EAL CONSULT BUILDING SUSTAINABILITY SINCE 2008

ENERGY & SUSTAINABILITY ASSESSMENT

LAND REAR OF 224 ST LEONARDS ROAD

PROPERTY ADDRESS

LAND REAR OF 224 ST LEONARDS RD
EAST SHEEN
LONDON
SW14 7BN

DATE

May 2024

PREPARED BY

EAL Consult

CONTENTS

1. EXECUTIVE SUMMARY

Site description

This Energy and Sustainability Assessment has been prepared to support the planning application for the erection of two new build semi-detached houses on the land rear of 224 St Leonards Road, East Sheen.

Strategy

The strategy highlights how the proposed development will promote sustainability throughout both design and operation and responds to the UK Planning and regulatory framework, National Planning Policy Framework 2023, the London Plan 2021 and Richmond's Local Plan, summarising how the relevant targets will be addressed and achieved.

Energy Hierarchy

In accordance with the Energy Hierarchy detailed within The London Plan 2021, this statement outlines an overall commitment to reducing energy consumption under occupancy through the adoption of a 'Fabric First' principle, which will seek to enhance insulation standards and improved heating and lighting efficiencies in comparison to the standard requirements of Approved Document Part L 2021. The viability of district heating will be explored. Further carbon emission reduction will be achieved by using renewable technologies.

- ***Be 'Lean':*** Passive design principles including a high level of insulation and reduced air permeabilty to deliver Part L compliant Building in absence of renewable technologies. It will achieve **24%** reduction in carbon emissions over Part L 2021 baseline.
- ***Be 'Clean':*** district heating was deemed not viable for this project
- ***Be 'Green':*** Air Source Heat Pumps and Solar Photovoltaic Panels have been proposed for the specific scheme and will deliver a further **64%** reduction in regulated carbon emissions over Part L 2021 baseline

Energy Effcicency & Carbon Reduction

- This report demonstrates that the proposed development by incorporating the measures above can achieve an **overall** carbon emission reduction of **88%**

Overheating

The development proposal will minimise adverse impacts on the urban heat island through design, layout, orientation and materials.

Ventilation

The development utilises natural ventilation in the building.

Sustainable Design:

- Natural lighting is incorporated to prevent excessive demand for artificial lighting
- The development will not increase the air pollution of the area
- Total internal water consumption will not exceed 105 litres/person/day
- All contractors should sign up to the nationally recognised Considerate Constructors Scheme
- Designated space for waste and recycling facilities
- Low Flood Risk area

Reducing Waste and Supporting the Circular Economy:

- Minimising the use of virgin materials during construction by recycling and reusing where feasible.
- Promote a more circular economy that improves resource efficiency and innovation to keep products and materials at their highest use for as long as possible
- Encourage waste minimisation and waste prevention through the reuse of materials and using fewer resources in the production and distribution of products
- Low waste benchmark levels will be targeted during construction with requirements identifying that the diversion of waste from landfill is to be achieved by the contractor.

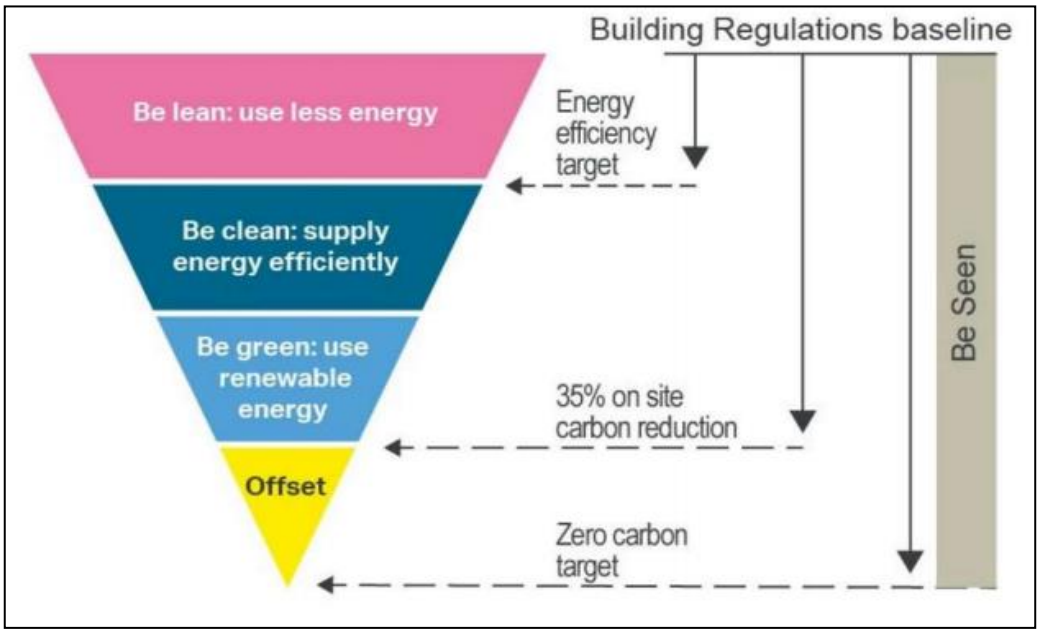
2. METHODOLOGY

This energy assessment outlines the energy demand from the development together with the associated CO_2 emissions, using Building Regulations Part L 2021 as a baseline. It demonstrates how the emissions from energy use in the development will be reduced through energy efficiency measures.

The proposed scheme is required to achieve carbon emission reduction principles in accordance with the UK Planning and regulatory framework.

The methodology employed to determine the potential CO_2 savings is in accordance with the three-step Energy Hierarchy.

Figure 1: The London Plan Energy Hierarchy



- ***Be 'Lean'*** **-** Improve the energy efficiency of the scheme;
- ***Be 'Clean'*** **-** Supply as much of the remaining energy requirement with low carbon; technologies such as district heating if available or combined heat and power (CHP); and
- ***Be 'Green'*** **-** Offset a proportion of the remaining carbon dioxide emissions by using renewable technologies.
- ***Be 'Seen'*** - monitor, verify and report on post-construction energy performance

The government approved Standard Assessment Procedure (SAP) methodology software (2021) has been used to determine the CO_2 emissions and energy requirements. It compares CO_2 emissions from regulated energy use (DER) with those of an equivalent dwelling built to Part L 2021 (TER), a notional dwelling of the same size and shape.

Opportunities for incorporating features into the development that contribute to the objectives of sustainable development were explored during the design process, to ensure that where possible, the proposals achieve best practice.

3. PLANNING POLICY CONTEXT

National Planning Policy Framework (NPPF) 2023

Emphasised the concept of sustainable development by encouraging local authorities to adopt proactive strategies to mitigate and adapt to climate change. It recommends the move to a low carbon future by:

- Avoiding increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and
- Contributing to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.
- To help increase the use and supply of renewable and low carbon energy and heat, plans should:
    - provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);
    - consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and
    - identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for colocating potential heat customers and suppliers.
- New updates emphasised that when determining planning applications, local planning authorities should give significant weight to the need to support energy efficiency and low carbon heating improvements to existing buildings, both domestic and non-domestic.

The London Plan 2021

Policy SI 2 Minimising Greenhouse Gas Emissions:

A. Proposals should make the fullest contribution to reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy: i) Be lean: use less energy and manage demand during operation, ii) Be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly, iii) Be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site, iiii) Be seen: monitor, verify and report on energy performance

B. A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either: i) through a cash in lieu contribution to the borough's carbon offset fund, or i) off-site provided that an alternative proposal is identified, and delivery is certain.

Policy 5.3 Sustainable Design and Construction

Major development proposals should meet minimum standards outlines in the supplementary guidance Sustainable Design and Construction SPG (2014), to consider the following principles:

a. Minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)
b. Avoiding internal overheating and contributing to the urban heat island effect
c. Efficient use of natural resources (including water), including making the most of natural systems both within and around buildings
d. Minimising pollution (including noise, air and urban runoff)
e. Minimising the generation of waste and maximising reuse or recycling
f. Avoiding impacts from natural hazards (including flooding)
g. Ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions
h. Securing sustainable procurement of materials, using local supplies where feasible, and
i. Promoting and protecting biodiversity and green infrastructure.

London Borough of Richmond Upon Thames – Local Plan 2018.

Policy LP 20 B1.
Minimise internal heat generation through energy efficient design

Policy LP 22
Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following:
1. Development of 1 dwelling unit or more, or 100sqm or more of non-residential floor space (including extensions) will be required to complete the Sustainable Construction Checklist SPD. A completed Checklist has to be submitted as part of the planning application.
2. Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption).
3. New non-residential buildings over 100sqm will be required to meet BREEAM 'Excellent' standard.
4. Proposals for change of use to residential will be required to meet BREEAM Domestic Refurbishment 'Excellent' standard (where feasible).

Reducing Carbon Dioxide Emissions
Developers are required to incorporate measures to improve energy conservation and efficiency as well as contributions to renewable and low carbon energy generation. Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions:
1. All new major residential developments (10 units or more) should achieve zero carbon standards in line with London Plan policy.
2. All other new residential buildings should achieve a 35% reduction.
3. All non-residential buildings over 100sqm should achieve a 35% reduction. From 2019 all major non residential buildings should achieve zero carbon standards in line with London Plan policy.

Targets are expressed as a percentage improvement over the target emission rate (TER) based on Part L of the 2013 Building Regulations. This should be achieved by following the Energy Hierarchy: 1. Be lean: use less energy 2. Be clean: supply energy efficiently 3. Be green: use renewable energy

4. ENERGY STRATEGY

The Energy strategy for the proposed development is based on the Building Regulations Part L; it adopts a set of principles to guide design and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. It seeks to incorporate energy efficiency through the approach detailed below.

The following tables and graph demonstrate the average carbon emissions and savings.

Table 1. Carbon Dioxide emissions after each stage of the Energy Hierarchy

	Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	**Unregulated**
Baseline: Part L 2021 of the Building Regulations Compliant Development	1.2	
After Energy Demand Reduction (Be Lean)	0.9	
After Heat Network Connection (Be Clean)	0.9	
After Renewables (Be Green)	0.1	

Table 2. Carbon Dioxide Savings from each stage of the Energy Hierarchy

	Regulated Carbon dioxide savings	
	Tonnes CO_2 per annum	**%**
Be Lean: Savings from Energy Demand Reduction	0.3	24
Be Clean: Savings from Heat Network	0	0
Be Green: Savings from Renewable Energy	0.8	64
Cumulative on-site savings	1.0	88
Carbon Shortfall	0.1	
(Tonnes CO2)		
Cumulative savings for off-set payment	4	
Cash in-lieu contribution	408	

a. Baseline Model

In accordance with London Plan Policy SI 2, a baseline model is run assuming the development complied with Part L 2021 of the Building Regulations. This baseline model is then used in the Energy Strategy process in comparison to the Be 'Lean', Be 'Clean' and Be 'Green' scenarios of the Energy Hierarchy, to establish the regulated CO^2 emissions from the development.

The baseline model used for this project assumed that any heating and hot water supply would be provided by a heatpump and any active cooling would be provided by electrically powered equipment. The comparative Be 'Lean' model assumes the same heating strategy.

b. Be 'Lean' - Demand Reduction

In accordance with London Plan Policy SI 2 the development must achieve at least a 10% improvement in energy efficiency on Building Regulations Part L 2021 baseline scenario.

The building fabric performance and engineering systems have been optimised in order to use less energy prior to the inclusion or consideration of Low and Zero Carbon (LZC) Technology.

Through passive design measures, efficient building fabric and engineering systems the building is estimated to achieve **24%** reduction in annual regulated CO_2 emissions over Part L benchmark, therefore demonstrating compliance with Building Regulations Through passive means alone without the utilisation of renewable technologies.

Passive Design Measures

Fabric Performance - The fabric performance values aim to reduce unwanted heat loss and heat gains, whilst maintaining a comfortable internal environment.

The heat loss of different building elements is dependent upon their U –value. A building with low U values provides better levels of insulation and reduced heating demand.

The development will incorporate high levels of insulation and efficient glazing; thereby reduce demand for space heating. The table below shows the U values for the development and the associated improvements over Building Regulations.

Table 3. Energy Efficient Design Specification

Element	Building Regulations 2021 Standard	Specification
Wall	0.18 W/m²k	0.15 W/m²k
Roof	0.11 W/m²k	0.11 W/m²k
Floor	0.13 W/m²k	0.12 W/m²k
Windows & Doors	1.2 W/m²k	1.2 W/m²k

Table 4. Development Part L Fabric Energy Efficiency Standard (FEES)

	Target Fabric Energy Efficiency (MWh/year)	Design Fabric Energy Efficiency (MWh/year)	Improvement %
Development Total	40.70	36.16	11

Thermal Bridging - Thermal bridging will be reduced. The thermal bridging calculations achieve an average y-value of 0.077 aligning with enhanced construction detail and cold bridges will be avoided.

Air Permeability – designed to achieve an air permeability score of 3

Thermal Mass - The average thermal mass is 150.8923 kJ/m2K.

Efficient Lighting and Controls - Throughout the development natural lighting will be optimised. The development will also incorporate low energy light fittings throughout. All light fittings will be specified as low energy lighting and will accommodate LED luminaries only.

Ventilation - The use of natural ventilation is proposed for the dwelling.

Space Heating & Cooling - Space heating will be provided by underfloor heating by the ASHP.

Domestic Hot Water (DHW) system – domestic hot water is supplied for the dwelling via the built in cylinder.

Waste Water Heat Recovery – A Zypho PiPe 75 System A instantaneous system will be used

Energy Use Intensity and Space Heating Demand

Table 5. Energy Use Intensity (EUI) and Space Heating Demand

Building type	EUI	Space heating demand	EUI value from Table 4 of the guidance	Space heating demand from Table 4 of the guidance	Methodology used
	excluding renewable energy (kWh/m^2/year)				
Residential	25.21	8.86	35	15	SAP10.2

c. Be 'Clean' - Supply Energy Efficiently

The Be Clean step of the energy hierarchy refers to the use of 'Clean energy supply'. This includes, but is not limited to, the use of Combined Heat and Power (CHP) and District Heat Networks. Policy SI 3 seeks for new development to promote the use of CHP and district heating.

Policy SI 1 Improving Air Quality

A. Development Plans, through relevant strategic, site-specific and area-based policies, should seek opportunities to identify and deliver further improvements to air quality and should not reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality.
B. To tackle poor air quality, protect health and meet legal obligations the following criteria should be addressed:
    1. Development proposals should not:
        a. lead to further deterioration of existing poor air quality
        b. create any new areas that exceed air quality limits, or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits

c. create unacceptable risk of high levels of exposure to poor air quality.

2. In order to meet the requirements in Part 1, as a minimum:
   a. development proposals must be at least Air Quality Neutral
   b. development proposals should use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality in preference to post-design or retro-fitted mitigation measures
   c. development proposals in Air Quality Focus Areas or that are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people should demonstrate that design measures have been used to minimise exposure.

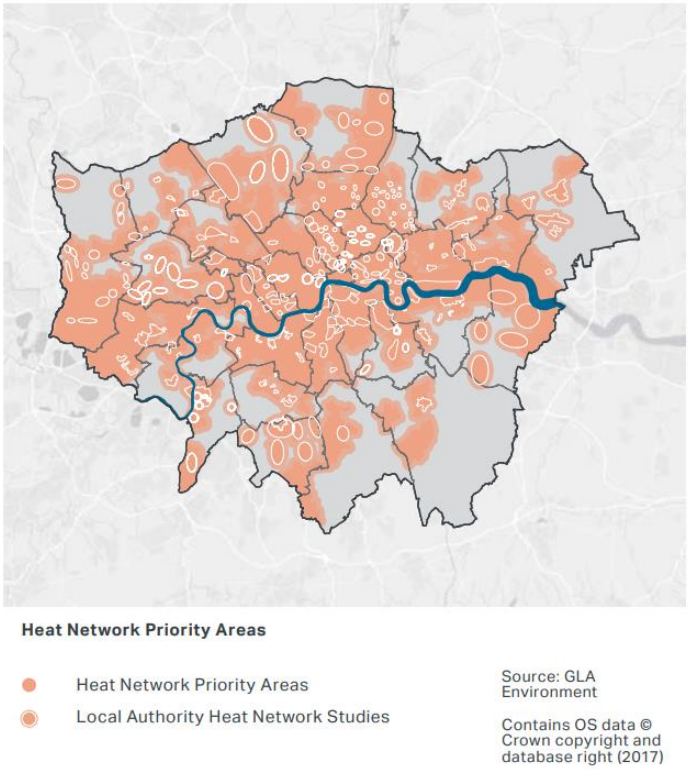
E. Development proposals should ensure that where emissions need to be reduced to meet the requirements of Air Quality Neutral or to make the impact of development on local air quality acceptable, this is done on-site. Where it can be demonstrated that emissions cannot be further reduced by on-site measures, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated within the area affected by the development.

Policy SI 3 Energy Infrastructure

A. Boroughs and developers should engage at an early stage with relevant energy companies and bodies to establish the future energy and infrastructure requirements arising from large-scale development proposals such as Opportunity Areas, Town Centres, other growth areas or clusters of significant new development.

C. Development Plans should:
   1. identify the need for, and suitable sites for, any necessary energy infrastructure requirements including energy centres, energy storage and upgrades to existing infrastructure
   2. identify existing heating and cooling networks, identify proposed locations for future heating and cooling networks and identify opportunities for expanding and inter-connecting existing networks as well as establishing new networks.

Figure 2 – Heat Network Priority Areas



District Heating and Cooling

There is no existing or planned heat and energy network in the vicinity and the site does not fall into an opportunity area with decentralised energy potential as identified in the London Plan. However, the development will be built ready to accommodate District Heating and Cooling should a local network be introduced in the future.

Community heating and Combined Heat and Power (CHP system)

CHP systems are usually needed where there is a large heat demand (schemes with more than 100-150 dwellings), usually resulting from the building(s) being in continuous use, or through specific heating requirements such as a swimming pool. Community (or district) heating involves using a central boiler plant (or other heat sources) to heat a number of buildings through a network of well-insulated underground pipes. This system is not considered appropriate for this development

In light of the small scale of the proposed development, it is apparent that the use of CHP is also technically and financially unviable in this instance.

Site-wide communal system/network and design for district network connection

In light of the small scale of the proposed development and it is location; it is apparent that the use a heatpump fed site-wide network is technically and financially unviable.

Air Quality

In line with London Plan Policy SI 1 all developments are required to demonstrate compliance with the Building Emission Benchmarks (BEB) set out in the Air Quality Neutral LPG. The BEB demonstrates the emissions from equipment used to supply heat and energy to the buildings.

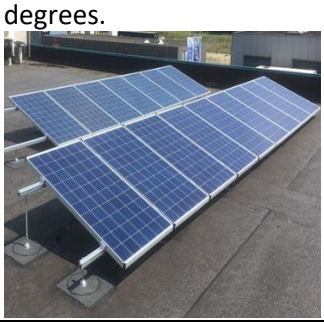
As the heating system proposed for this development is a heat pump, in accordance with the Air Quality Neutral LPG it is assumed that this project meets BEB and a full Air Quality Neutral (AQN) Assessment is not required.

d. Be 'Green' - Renewable Energy

Once energy demand reduction measures have been applied, methods for generating low and zero carbon energy can be assessed. The following renewable technologies can be considered for the project: Biomass, Water source heat pump, air source heat pump, Wind energy and solar photovoltaic panels.

Table 6. Renewable Technologies Feasibility Table

Technology	Pros	Cons
Biomass Heating A biomass system designed for wood pellets, which have a high-energy content, would fuel this development. 	• Less volume of storage • Less maintenance and produce considerably less ash residue	• Nox Emissions which may impacts • High Costs • Not suitable for the project

Ground Source Heat Pump It circulates a mixture of water and antifreeze around a loop of pipe, called a ground loop, which is buried in the garden. Heat from the ground is absorbed into the fluid and passes through a heat exchanger into the heat pump 	• Use all through the year	• High Costs • Not suitable for this project
Air Source Heat Pump They are an efficient and environmentally-friendly way of heating using air drawn freely from the atmosphere. They operate rather like a refrigerator in reverse, absorbing heat from the air into a working fluid which is passed into a compressor where its temperature is increased before it is transferred into the heating and hot water circuits of the building	• Can generate less CO_2 than conventional heating systems. • Cheaper • Provides heating and hot water • Less maintenance • Can be used as air-conditioning in the summer	• Needs electricity • Can be noisy
Wind Turbines Wind turbines are available in various sizes from large rotors able to supply whole communities to small roof or wall-mounted units for individual dwellings. 	• Cheaper • Less CO_2	• Local wind speeds in the area is likely to be below the level generally required for investment in large wind turbines. • Noise and signal interference. • Detrimental aesthetic impact
Solar Photovoltaic Panels (PV) Photovoltaic panels extract the energy of the sun to generate electricity. They operate most efficiently when oriented to the south and are inclined to about 35 degrees. 	• Cheaper • Less CO_2 • No input power in order to generate electricity.	

Renewable Technologies Feasibility Review Conclusion

The renewable energy sources that have been reviewed for this project are Biomass Heating, Ground Source Heat Pump, Air Source Heat Pump, Domestic Wind Turbine and Solar Photovoltaic Panels (PV).

On review of the above technologies, it has been concluded that the use of an air source heat pump and PV panels are to be incorporated in the design because it achieves a CO_2 percentage reduction of **64%** contributing to an overall reduction of **88%** in carbon emissions.

Table 7. Photovoltaic Panels

House	System size	Orientatiom	Degree	Panels
1	2.5 kWp	West	30	10 (approx)
2	2.5 kWp	East	30	10 (approx)

Table 8. ASHP Specification

Seasonal Coefficient of Performance (SCOP)		Seasonal Energy Efficiency Ratio (SEER)	
35°C	55°C	7°C	18°C
5.2	3.47	5.95	8.73

e. Be 'Seen' - Monitoring Performance

In accordance with London Plan Policy Guidance 'Be Seen' Energy Monitoring 1.2, the following is suggested:
1.2.1 To truly achieve net zero-carbon buildings we need to have a better understanding of their actual operational energy performance. Although Part L calculations and Energy Performance Certificates (EPCs) give an indication of the theoretical performance of buildings, it is well established that there is a 'performance gap' between design theory and measured reality.

1.2.2 To address this gap the London Plan Policy SI 2 'Minimising greenhouse gas emissions' introduces a fourth stage to the energy hierarchy; the 'be seen' stage, which requires monitoring and reporting of the actual operational energy performance of major developments for at least five years via the Mayor's 'be seen' monitoring portal.

1.2.3 The 'be seen' policy establishes post-construction monitoring as good practice, enabling developers and building owners to better understand their buildings and identify methods for improving energy performance from the project inception stage and throughout the building's lifetime.

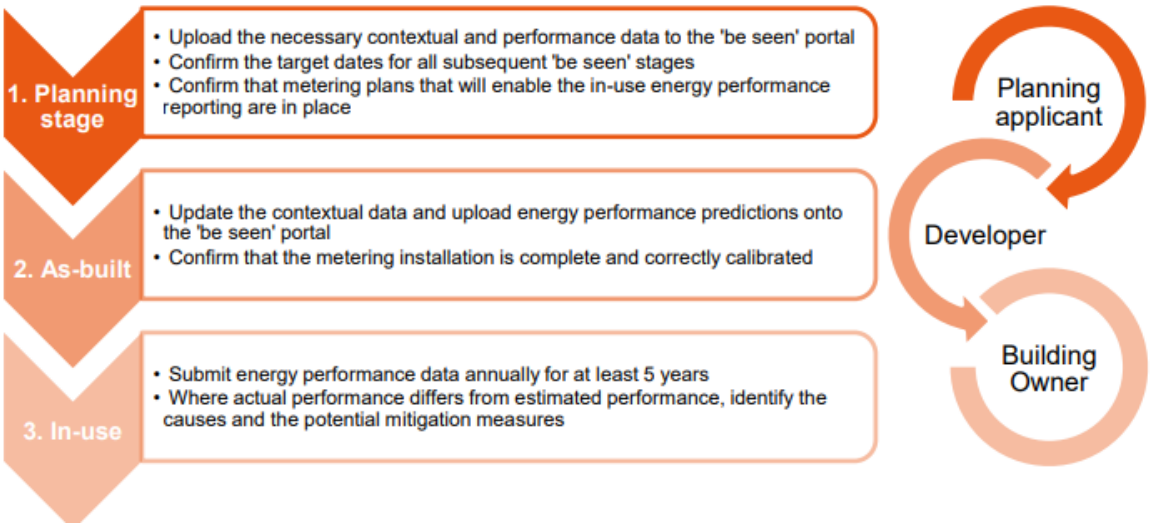
1.2.4 Ensuring that the actual energy and carbon performance of buildings is aligned with the estimated energy and carbon performance will also be a key factor in achieving a zero-carbon London.

1.2.5 The energy performance data that will be collected will provide an evidence base which could help inform future industry-wide benchmarks or performance ratings for major building typologies based on in-use performance

1.2.6 An effectively implemented post-construction monitoring regime can have a number of benefits including environmental (for example, carbon emissions reduction) and socio-economic (for example, reduced occupants' bills, raised awareness around energy usage).

Figure 3 outlines the 'be seen' process through the reporting stages of a development

Figure 3 'Be seen' process and responsibilities



As the dwellings achieve an EPC rating of A92, the operational running costs will be low due to the high performance. As the development includes renewable technologies it is less reliant on the main grid and will protect the consumer from high prices.

Smart metering equipment will be installed with display of energy usage and generation to raise awareness of occupants. This can help occupants to reduce demand and subsequent running costs. The GLA spreadsheet informs the planning stage energy performance data including carbon offset. An on-site operational manual will be provided for the occupants on completion of the build to assist residents better understanding of appliances and cost management.

5. SUSTAINABILITY STRATEGY

a. Sustainable Design

London Plan Policy 5.3 Sustainable Design and Construction and Sustainable Design and Construction SPG (2014) to consider the following principles:

a. Minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)
b. Avoiding internal overheating and contributing to the urban heat island effect
c. Efficient use of natural resources (including water), including making the most of natural systems both within and around buildings
d. Minimising pollution (including noise, air and urban runoff)
e. Minimising the generation of waste and maximising reuse or recycling
f. Avoiding impacts from natural hazards (including flooding)
g. Ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions
h. Securing sustainable procurement of materials, using local supplies where feasible, and
i. Promoting and protecting biodiversity and green infrastructure.

The proposed project incorporates sustainable design and construction measures capable of mitigating and adapting to climate change to meet future needs. This section details site-specific initiatives which demonstrate how the conversion helps to meet the sustainability objectives set out in the National Planning Framework 2021.

Materials Efficiency

Materials can have a significant impact on environmental performance, both in construction but also ongoing use. Materials used for the building will have lower environmental impacts over their lifecycle. This applies to the materials used in the external walls, roof and glazing. This extends to elements of the materials category such as the basic building materials (internal walls) and the finishing elements (fascia, skirting, and furniture).

b. Overheating Strategy

Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

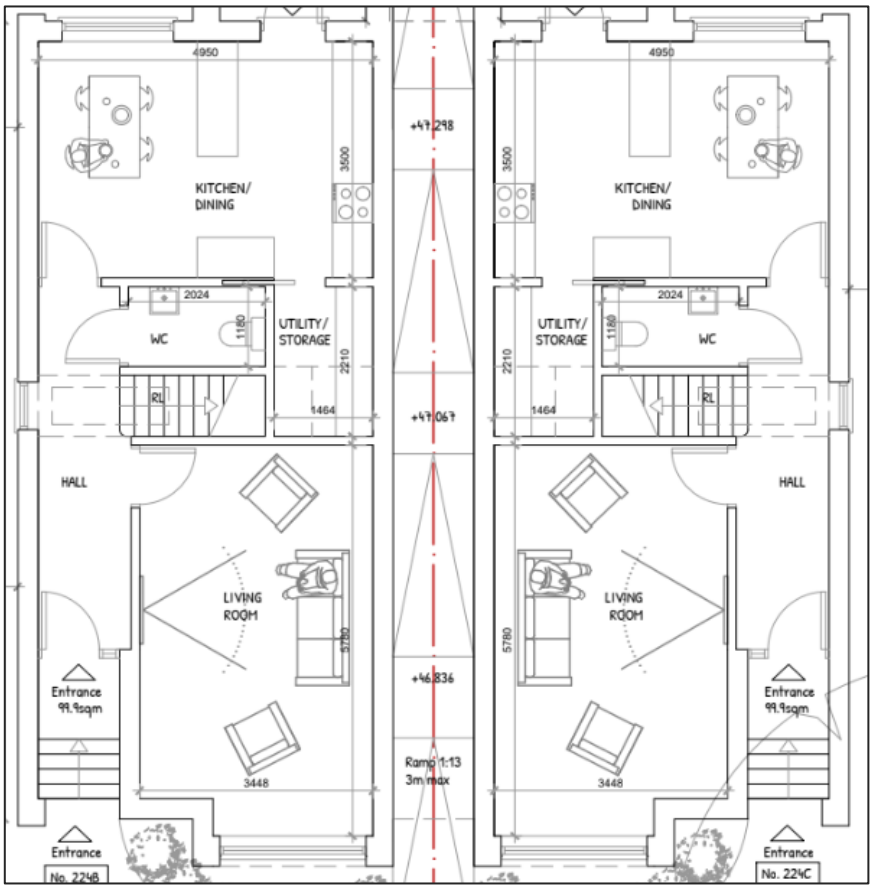
Minimise Heat Generation Through Energy Efficient Design

Through the use of passive and active design measures, the design team have enabled the development to require less energy through the use of optimised insulation, cross ventilation, improved window u-values, higher air tightness and reduced cold bridging. The GHA Overheating Tool has been completed and can be found in the Appendix. The tool showed a low risk of overheating.

Daylight

The design of the development has taken into consideration day lighting to habitable spaces to improve the wellbeing of occupants. Good levels of daylight will offer occupants a pleasant and highly valued connection to the outdoors and plenty of natural light. It will also reduce the use of artificial lighting and therefore energy use. All light fittings will be specified as low energy lighting. No external lighting is required. The location and orientation of windows help to create a design that avoids overheating in the summer.

Figure 4. Internal layout



c. Water Efficiency

Water: Water Efficiency

In domestic and non-domestic buildings, the demand for water can be reduced as much as 50% using a variety of simple and innovative strategies that are integrated into the plumbing and mechanical systems. In order to reduce water consumption the proposed development will include efficient fixtures with low flow rates. Total internal water consumption will not exceed 105 litres/person/day.

Table 10. Water Fittings Standards

Schedule Appliance Water Consumption		
Appliance	**Flow rate or Capacity**	**Total Litres**
WC	Dual flush WC 4/2.6 litre	14.72
Basin	1.7 litres/min	5.98
Shower	8 litres/minute flow	24.00
Bath	160 litres	25.60
Sink	4 litres/min	14.13
W/machine	Default used	16.66
Dish Washer	Default used	3.90
		104.99

d. Pollution: Light, Air and Noise

Light

Light pollution can best be described as artificial light that is allowed to illuminate or intrude upon areas not intended to be lit. Light in the wrong place at the wrong time can be intrusive.
Intrusive light is over bright or poorly directed lights shining onto neighbouring property which affect the neighbours' right to enjoy their property. Therefore, the proposal will incorporate lighting measures in order to avoid causing a nuisance.

Air and Noise

The layout of the development can provide good internal air quality for habitable areas but not too much so as to waste heat.

The use of openable windows will create horizontal airflow. By achieving a good naturally ventilated building the energy demand for air conditioning and mechanical ventilation will thereby be eliminated within the development.

The development will not increase the air pollution of the area by reducing as a start, its energy use, which in turn will reduce emissions that lead to air pollution.
Other measures will include:

a. Use of eco-friendly building materials
b. Non-toxic paints
c. Installation of energy efficient appliances and devices
d. Use of renewable technologies

e. Waste Management

Considerate Construction

All contractors would be required to sign up to the nationally recognised Considerate Constructors Scheme which requires, amongst other things that dust emissions, potential noise pollution, impacts on water quality and the potential for ground contamination are minimised during demolition and construction. The Contractor would also be obliged to adhere to a site-specific Code of Construction Practice to reduce potential nuisance effects.

Resource efficiency

- Pre-demolition audit to be carried out and target benchmark of ≤ 11.1 tonnes of construction waste per 100m^2;

Diversion of waste from landfill

- Where possible, segregation of recyclable and non-recyclable material will be employed for all waste generated throughout the construction process. Furthermore, material will be re-used on-site where feasible;
- Pre-fabrication of materials/elements such as bathroom pods, pipework and riser materials will be considered;
- Reusable packing solutions with key product manufacturers will be explored at the earliest opportunity. Solutions may include flat pallets, bulk bags, steel stillages and returnable cable drums;
- Construction waste – minimum 80% diversion from landfill rate;
- Demolition waste – minimum 90% diversion from landfill rate;

Operational Waste

Target diversion from landfill rate to be set.

A space for reuse and recycling has been included at the ground floor unit for the residents exclusive use.

f. Flood Risk

The development site is located in a Low Flood Risk Area on the Environment Agency Flood Risk Map.

g. Sustainable Procurement

It is expected that all timber used in the development will come from a legal Source (FSC Scheme). At least 80% of the building materials will be responsibly sourced and will use suppliers who can provide an EMS certificate or equivalent. Materials rated with an A or B in the BRE Green Guide to Specification will be preferred.

Other measures will be implemented:

- The reuse of existing materials from the demolition of existing buildings
- At least 20% of the total value of materials used should derive from recycled and reused content in the products and materials selected;
- Steel will have a high recycled content;
- Concrete will have a Ground Granulated Blast Furnace Slag (GGBS) value of 50%.

h. Biodiversity and Green Infrastructure

The proposed development will achieve an urban greening factor score of 0.5 with the below measures.

Urban Greening Factor Calculator			
Surface Cover Type	**Factor**	**Area (m^2)**	**Contribution**
Semi-natural vegetation (e.g. trees, woodland, species-rich grassland) maintained or established on site.	1		0
Wetland or open water (semi-natural; not chlorinated) maintained or established on site.	1		0
Intensive green roof or vegetation over structure. Substrate minimum settled depth of 150mm.	0.8		0
Standard trees planted in connected tree pits with a minimum soil volume equivalent to at least two thirds of the projected canopy area of the mature tree.	0.8	70	56
Extensive green roof with substrate of minimum settled depth of 80mm (or 60mm beneath vegetation blanket) – meets the requirements of GRO Code 2014.	0.7		0
Flower-rich perennial planting.	0.7	8	5.6
Rain gardens and other vegetated sustainable drainage elements.	0.7		0
Hedges (line of mature shrubs one or two shrubs wide).	0.6		0
Standard trees planted in pits with soil volumes less than two thirds of the projected canopy area of the mature tree.	0.6		0
Green wall –modular system or climbers rooted in soil.	0.6		0
Groundcover planting.	0.5		0
Amenity grassland (species-poor, regularly mown lawn).	0.4	43	17.2
Extensive green roof of sedum mat or other lightweight systems that do not meet GRO Code 2014.	0.3		0
Water features (chlorinated) or unplanted detention basins.	0.2		0
Permeable paving.	0.1	24	2.4
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone).	0		0
Total contribution			**81.2**
Total site area (m^2)			156
Urban Greening Factor			**0.5**

6. CONCLUSION

The development has been designed to exceed Part L building regulations requirements. In line with the national and local policies, regulated CO_2 emissions from the development will be reduced by **88%** from the notional emissions once energy efficiency measures and lean measures are taken into account.

The use of air source heat pumps and photovoltaic panels are to be incorporated in the design because they achieve a CO2 percentage reduction of **64%** contributing to the overall reduction of **88%** in carbon emissions. The remainder is made up from a fabric first approach with U-values outlined in the specification column of Table 3 on Page 9 of this report.

An appraisal of the proposed development has been undertaken against key sustainability objectives identified from relevant policy guidance. The framework for the appraisal was guided by the National Plan. This process has ensured that the development responds to the sustainable development objectives that are relevant to the area. Key sustainability initiatives in ecology, waste management, water, health and wellbeing, materials, pollution and Surface water management have been incorporated in the design of the proposed Development.

7. APPENDIX

A. SAP Calculations

i. Baseline

Full SAP Calculation Printout

Property Reference	224 St Leonards	**Issued on Date**	15/05/2024
Assessment Reference	Option 1 - House 1	**Prop Type Ref**	224 St Leonards
Property	Land Rear of 224, St Leonards Road, LONDON, SW14 7BN		

SAP Rating	71 C	**DER**	6.27	**TER**	10.70
Environmental	94 A	**% DER < TER**			41.40
CO_2 Emissions (t/year)	0.61	**DFEE**	52.66	**TFEE**	40.70
Compliance Check	See BREL	**% DFEE < TFEE**			-29.37
% DPER < TPER	-18.30	**DPER**	66.01	**TPER**	55.80

Assessor Details	Mr. Mark Simons	**Assessor ID**	5542-0001
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	53.4100 (1b)	x	2.5000 (2b)	=	133.5250	(1b) - (3b)
First floor	55.9000 (1c)	x	2.0000 (2c)	=	111.8000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	109.3100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	245.3250	(5)

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2. Ventilation rate

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			m3 per hour	
Number of open chimneys		0 * 80 =	0.0000	(6a)
Number of open flues		0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire		0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler		0 * 20 =	0.0000	(6d)
Number of flues attached to other heater		0 * 35 =	0.0000	(6e)
Number of blocked chimneys		0 * 20 =	0.0000	(6f)
Number of intermittent extract fans		3 * 10 =	30.0000	(7a)
Number of passive vents		0 * 10 =	0.0000	(7b)
Number of flueless gas fires		0 * 40 =	0.0000	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =		30.0000 / (5) =	0.1223	(8)
Pressure test			Yes	
Pressure Test Method			Blower Door	
Measured/design AP50			8.0000	(17)
Infiltration rate			0.5223	(18)
Number of sides sheltered			0	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor		(21) = (18) x (20) =	0.5223	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.6659	0.6529	0.6398	0.5745	0.5615	0.4962	0.4962	0.4831	0.5223	0.5615	0.5876	0.6137	(22b)
Effective ac	0.7217	0.7131	0.7047	0.6650	0.6576	0.6231	0.6231	0.6167	0.6364	0.6576	0.6726	0.6883	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
WINDOWS (Uw = 1.40)			16.6900	1.3258	22.1269			(27)
ROOFLIGHTS			5.5200	1.3258	7.3182			(27a)
ROOFLIGHTS			1.2800	1.3258	1.6970			(27a)
UNDERGROUND			53.4100	0.2200	11.7502	75.0000	4005.7500	(28a)
EXTERNAL	108.3200	16.6900	91.6300	0.2800	25.6564	70.0000	6414.1000	(29a)
ROOF VOID	8.9800		8.9800	0.2500	2.2450	18.0000	161.6400	(29a)
PITCHED @CEILING	8.0100		8.0100	0.1800	1.4418	9.0000	72.0900	(30)
PITCHED @RAFTER	75.3900	6.8000	68.5900	0.1600	10.9744	9.0000	617.3100	(30)
Total net area of external elements Aum(A, m2)			254.1100					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	83.2098			(33)
PARTY WALL			21.3900	0.0000	0.0000	180.0000	3850.2000	(32)
FF			50.8500			18.0000	915.3000	(32d)
GF			50.8500			9.0000	457.6500	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16494.0400 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		150.8923 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E2 Other lintels (including other steel lintels)	10.8900	0.3000	3.2670

E3 Sill	8.8300	0.0400	0.3532	
E4 Jamb	27.2800	0.0500	1.3640	
E5 Ground floor (normal)	33.4000	0.1600	5.3440	
E20 Exposed floor (normal)	0.9000	0.3200	0.2880	
E6 Intermediate floor within a dwelling	11.7400	0.0700	0.8218	
E13 Gable (insulation at rafter level)	13.5000	0.0400	0.5400	
E16 Corner (normal)	15.0000	0.0900	1.3500	
E17 Corner (inverted - internal area greater than external area)	5.0000	-0.0900	-0.4500	
P7 Party Wall - Exposed floor (normal)	11.2000	0.1600	1.7920	
P5 Party wall - Roof (insulation at rafter level)	11.2000	0.0800	0.8960	
R1 Head of roof window	10.3700	0.0800	0.8296	
R2 Sill of roof window	9.0100	0.0600	0.5406	
R3 Jamb of roof window	11.6600	0.0800	0.9328	
R8 Roof to wall (rafter)	10.0400	0.0600	0.6024	
E10 Eaves (insulation at ceiling level)	11.2000	0.0600	0.6720	
E12 Gable (insulation at ceiling level)	1.6000	0.2400	0.3840	

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 19.5274 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 102.7372 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	58.4286	57.7316	57.0484	53.8393	53.2389	50.4439	50.4439	49.9264	51.5205	53.2389	54.4535	55.7233	(38)
Heat transfer coeff	161.1659	160.4688	159.7856	156.5766	155.9762	153.1812	153.1812	152.6636	154.2578	155.9762	157.1908	158.4606	(39)
Average = Sum(39)m / 12 =												156.5737	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.4744	1.4680	1.4618	1.4324	1.4269	1.4013	1.4013	1.3966	1.4112	1.4269	1.4380	1.4496	(40)
HLP (average)												1.4324	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8106 (42)
Hot water usage for mixer showers

71.3447	70.2725	68.7101	65.7208	63.5148	61.0547	59.6563	61.2068	62.9065	65.5480	68.6015	71.0713	(42a)

Hot water usage for baths

32.4250	31.9435	31.2653	30.0150	29.0787	28.0406	27.4798	28.1532	28.8864	29.9973	31.2734	32.3154	(42b)

Hot water usage for other uses

45.6985	44.0367	42.3750	40.7132	39.0514	37.3897	37.3897	39.0514	40.7132	42.3750	44.0367	45.6985	(42c)

Average daily hot water use (litres/day) 137.3846 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	149.4682	146.2527	142.3504	136.4490	131.6449	126.4849	124.5258	128.4115	132.5061	137.9202	143.9116	149.0852	(44)
Energy conte	236.7210	208.2619	218.7873	186.7919	177.2194	155.5279	150.6031	159.0002	163.3933	187.1564	205.0284	233.4314	(45)
Energy content (annual)										Total = Sum(45)m =		2281.9222	
Distribution loss (46)m = 0.15 x (45)m	35.5082	31.2393	32.8181	28.0188	26.5829	23.3292	22.5905	23.8500	24.5090	28.0735	30.7543	35.0147	(46)

Water storage loss:
Store volume 200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 2.1000 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 1.1340 (55)

Total storage loss	35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(56)
If cylinder contains dedicated solar storage	35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(64)
										Total per year (kWh/year) = Sum(64)m =		2969.7282	(64)
12Total per year (kWh/year)												2970	(64)

Electric shower(s)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)

Heat gains from water heating, kWh/month

125.4429	111.4576	119.4799	107.3339	105.6586	96.9386	96.8087	99.6007	99.5539	108.9626	113.3975	124.3491	(65)

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	136.4389	151.0573	136.4389	140.9868	136.4389	140.9868	136.4389	136.4389	140.9868	136.4389	140.9868	136.4389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	270.5609	273.3685	266.2935	251.2317	232.2188	214.3494	202.4115	199.6039	206.6789	221.7408	240.7537	258.6231	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	(71)
Water heating gains (Table 5)	168.6060	165.8596	160.5913	149.0748	142.0142	134.6370	130.1192	133.8719	138.2693	146.4551	157.4966	167.1358	(72)
Total internal gains	640.7651	655.4447	628.4829	606.4527	575.8312	555.1325	534.1289	535.0740	551.0943	569.7941	604.3964	627.3571	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W

North	8.8900	10.6334	0.6300	0.7000	0.7700	28.8899	(74)
South	6.2600	46.7521	0.6300	0.7000	0.7700	89.4431	(78)
West	1.5400	19.6403	0.6300	0.7000	0.7700	9.2436	(80)
East	1.2800	26.6072	0.6300	0.7000	1.0000	13.5173	(82)
West	5.2500	26.6072	0.6300	0.7000	1.0000	58.2935	(82)

Solar gains	199.3873	364.9577	561.0444	789.4521	963.7180	989.9412	940.7256	806.8066	640.1402	420.5293	243.5677	167.4887	(83)
Total gains	840.1524	1020.4024	1189.5274	1395.9048	1539.5491	1545.0737	1474.8545	1341.8806	1191.2346	990.3233	847.9641	794.8458	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	28.4283	28.5518	28.6739	29.2616	29.3742	29.9102	29.9102	30.0116	29.7014	29.3742	29.1472	28.9137	
alpha	2.8952	2.9035	2.9116	2.9508	2.9583	2.9940	2.9940	3.0008	2.9801	2.9583	2.9431	2.9276	
util living area	0.9761	0.9581	0.9246	0.8475	0.7247	0.5636	0.4321	0.4847	0.7052	0.8946	0.9613	0.9794	(86)
Living	20.0668	20.1541	20.2824	20.4516	20.5773	20.6556	20.6800	20.6756	20.6160	20.4438	20.2327	20.0624	
Non living	18.5954	18.7097	18.8741	19.0994	19.2459	19.3435	19.3625	19.3642	19.3025	19.0998	18.8309	18.6066	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	31	30	31	31	30	31	30	31	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	19.7068	19.7116	19.7163	19.7386	19.7428	19.7623	19.7623	19.7659	19.7548	19.7428	19.7343	19.7255	(88)
util rest of house	0.9709	0.9491	0.9082	0.8146	0.6666	0.4757	0.3205	0.3694	0.6233	0.8640	0.9515	0.9749	(89)
MIT 2	19.7068	19.7116	19.7163	19.7386	19.7428	19.7623	19.7623	19.7659	19.7548	19.7428	19.7343	19.7255	(90)
Living area fraction									fLA = Living area / (4) =			0.1768	(91)
MIT	19.9355	19.9394	19.9433	19.9616	19.9651	19.9812	19.9812	19.9842	19.9750	19.9651	19.9581	19.9509	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9355	19.9394	19.9433	19.9616	19.9651	19.9812	19.9812	19.9842	19.9750	19.9651	19.9581	19.9509	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9719	0.9509	0.9114	0.8210	0.6778	0.4922	0.3411	0.3909	0.6393	0.8701	0.9535	0.9758	(94)
Useful gains	816.5375	970.2859	1084.1052	1146.0316	1043.4317	760.4971	503.0592	524.5915	761.5309	861.7004	808.4924	775.6231	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2519.9011	2413.3573	2148.0465	1731.9937	1289.1562	824.2942	517.9319	547.1708	906.2589	1460.7300	2021.1781	2495.8907	(97)
Space heating kWh	1267.3025	969.7440	791.5723	421.8927	182.8190	0.0000	0.0000	0.0000	0.0000	445.6780	873.1337	1279.8791	(98a)
Space heating requirement - total per year (kWh/year)												6232.0213	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	1267.3025	969.7440	791.5723	421.8927	182.8190	0.0000	0.0000	0.0000	0.0000	445.6780	873.1337	1279.8791	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6232.0213	
Space heating per m2											(98c) / (4) =	57.0124	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	372.4659 (206)
Efficiency of main space heating system 2 (in %)	0.0000 (207)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1267.3025	969.7440	791.5723	421.8927	182.8190	0.0000	0.0000	0.0000	0.0000	445.6780	873.1337	1279.8791	(98)
Space heating efficiency (main heating system 1)	372.4659	372.4659	372.4659	372.4659	372.4659	0.0000	0.0000	0.0000	0.0000	372.4659	372.4659	372.4659	(210)
Space heating fuel (main heating system)	340.2466	260.3578	212.5221	113.2702	49.0834	0.0000	0.0000	0.0000	0.0000	119.6561	234.4198	343.6232	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(64)
Efficiency of water heater												116.0400	(216)
(217)m	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	(217)
Fuel for water heating, kWh/month	254.3411	224.9440	238.8863	209.6896	203.0643	182.7473	180.1271	187.3635	189.5254	211.6277	225.4054	251.5062	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	55.4962	44.5211	40.0863	29.3690	22.6854	18.5342	20.6944	26.8994	34.9396	45.8427	51.7792	57.0386	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)												
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	1673.1791	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	116.0400	
Water heating fuel used	2559.2281	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	0.0000	(231)
Electricity for lighting (calculated in Appendix L)	447.8860	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	4680.2932	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1673.1791	0.1554	259.9912	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2559.2281	0.1409	360.6321	(264)
Space and water heating			620.6232	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	447.8860	0.1443	64.6438	(268)
Total CO2, kg/year			685.2670	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			6.2700	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1673.1791	1.5753	2635.7104	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2559.2281	1.5211	3892.7165	(278)
Space and water heating			6528.4270	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	447.8860	1.5338	686.9825	(282)
Total Primary energy kWh/year			7215.4095	(286)
Dwelling Primary energy Rate (DPER)			66.0100	(287)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	53.4100	(1b)	x 2.5000	(2b) =	133.5250	(1b) - (3b)
First floor	55.9000	(1c)	x 2.0000	(2c) =	111.8000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	109.3100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		245.3250	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.1630	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4130	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.4130	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)

Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate	0.5266	0.5163	0.5060	0.4544	0.4440	0.3924	0.3924	0.3821	0.4130	0.4440	0.4647	0.4853 (22b)
Effective ac	0.6387	0.6333	0.6280	0.6032	0.5986	0.5770	0.5770	0.5730	0.5853	0.5986	0.6080	0.6178 (25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			16.6900	1.1450	19.1107			(27)
ROOFLIGHTS			5.5200	2.0221	11.1618			(27a)
ROOFLIGHTS			1.2800	2.0221	2.5882			(27a)
UNDERGROUND			53.4100	0.1300	6.9433			(28a)
EXTERNAL	108.3200	16.6900	91.6300	0.1800	16.4934			(29a)
ROOF VOID	8.9800		8.9800	0.1800	1.6164			(29a)
PITCHED @CEILING	8.0100		8.0100	0.1100	0.8811			(30)
PITCHED @RAFTER	75.3900	6.8000	68.5900	0.1100	7.5449			(30)
Total net area of external elements Aum(A, m2)			254.1100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		66.3398			(33)
PARTY WALL			21.3900	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 150.8923 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E2	Other lintels (including other steel lintels)	10.8900	0.0500	0.5445
E3	Sill	8.8300	0.0500	0.4415
E4	Jamb	27.2800	0.0500	1.3640
E5	Ground floor (normal)	33.4000	0.1600	5.3440
E20	Exposed floor (normal)	0.9000	0.3200	0.2880
E6	Intermediate floor within a dwelling	11.7400	0.0000	0.0000
E13	Gable (insulation at rafter level)	13.5000	0.0800	1.0800
E16	Corner (normal)	15.0000	0.0900	1.3500
E17	Corner (inverted - internal area greater than external area)	5.0000	-0.0900	-0.4500
P7	Party Wall - Exposed floor (normal)	11.2000	0.1600	1.7920
P5	Party wall - Roof (insulation at rafter level)	11.2000	0.0800	0.8960
R1	Head of roof window	10.3700	0.0800	0.8296
R2	Sill of roof window	9.0100	0.0600	0.5406
R3	Jamb of roof window	11.6600	0.0800	0.9328
R8	Roof to wall (rafter)	10.0400	0.0600	0.6024
E10	Eaves (insulation at ceiling level)	11.2000	0.0600	0.6720
E12	Gable (insulation at ceiling level)	1.6000	0.0600	0.0960

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 16.3234 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 82.6632 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	51.7053	51.2693	50.8420	48.8349	48.4594	46.7113	46.7113	46.3876	47.3847	48.4594	49.2191	50.0133	(38)
Heat transfer coeff	134.3684	133.9325	133.5052	131.4981	131.1226	129.3745	129.3745	129.0508	130.0478	131.1226	131.8823	132.6765	(39)

Average = Sum(39)m / 12 = 131.4963

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2292	1.2253	1.2213	1.2030	1.1995	1.1836	1.1836	1.1806	1.1897	1.1995	1.2065	1.2138	(40)
HLP (average)												1.2030	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8106 (42)

Hot water usage for mixer showers	71.3447	70.2725	68.7101	65.7208	63.5148	61.0547	59.6563	61.2068	62.9065	65.5480	68.6015	71.0713 (42a)
Hot water usage for baths	30.8038	30.3463	29.7021	28.5142	27.6248	26.6385	26.1058	26.7455	27.4421	28.4974	29.7097	30.6996 (42b)
Hot water usage for other uses	43.4136	41.8349	40.2562	38.6775	37.0989	35.5202	35.5202	37.0989	38.6775	40.2562	41.8349	43.4136 (42c)

Average daily hot water use (litres/day) 133.8042 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	145.5620	142.4537	138.6684	132.9126	128.2384	123.2134	121.2823	125.0512	129.0261	134.3016	140.1461	145.1845	(44)
Energy conte	230.5346	202.8521	213.1282	181.9507	172.6336	151.5052	146.6804	154.8396	159.1021	182.2460	199.6638	227.3238	(45)
Energy content (annual)										Total = Sum(45)m =		2222.4601	
Distribution loss (46)m = 0.15 x (45)m	34.5802	30.4278	31.9692	27.2926	25.8950	22.7258	22.0021	23.2259	23.8653	27.3369	29.9496	34.0986	(46)

Water storage loss:

Store volume 200.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.6525 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8924 (55)

Total storage loss	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(56)
If cylinder contains dedicated solar storage	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	281.4607	248.8499	264.0542	231.2340	223.5597	200.7885	197.6065	205.7656	208.3854	233.1720	248.9471	278.2499	(62)
WWHRS	-32.6158	-28.8457	-30.2055	-25.0114	-23.3097	-19.9463	-18.6965	-19.8818	-20.6372	-24.3290	-27.5618	-32.0118	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	248.8449	220.0042	233.8487	206.2226	200.2500	180.8422	178.9101	185.8838	187.7482	208.8431	221.3853	246.2381	(64)
										Total per year (kWh/year) = Sum(64)m =		2519.0212	(64)
12Total per year (kWh/year)												2519	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	117.3936	104.2465	111.6060	99.9252	98.1415	89.8021	89.5121	92.2250	92.3281	101.3376	105.8148	116.3260	(65)

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	136.4389	151.0573	136.4389	140.9868	136.4389	140.9868	136.4389	136.4389	140.9868	136.4389	140.9868	136.4389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	270.5609	273.3685	266.2935	251.2317	232.2188	214.3494	202.4115	199.6039	206.6789	221.7408	240.7537	258.6231	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	(71)
Water heating gains (Table 5)													
	157.7871	155.1288	150.0080	138.7851	131.9107	124.7252	120.3120	123.9584	128.2335	136.2065	146.9651	156.3522	(72)
Total internal gains													
	632.9462	647.7139	620.8997	599.1629	568.7276	545.2207	524.3217	525.1605	541.0586	562.5455	596.8648	619.5734	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	8.8900	10.6334	0.6300	0.7000	0.7700	28.8899	(74)
South	6.2600	46.7521	0.6300	0.7000	0.7700	89.4431	(78)
West	1.5400	19.6403	0.6300	0.7000	0.7700	9.2436	(80)
East	1.2800	26.6072	0.6300	0.7000	1.0000	13.5173	(82)
West	5.5200	26.6072	0.6300	0.7000	1.0000	58.2935	(82)

Solar gains	199.3873	364.9577	561.0444	789.4521	963.7180	989.9412	940.7256	806.8066	640.1402	420.5293	243.5677	167.4887	(83)
Total gains	832.3336	1012.6716	1181.9442	1388.6150	1532.4456	1535.1619	1465.0473	1331.9670	1181.1988	983.0747	840.4325	787.0622	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	34.0979	34.2089	34.3184	34.8422	34.9419	35.4141	35.4141	35.5029	35.2307	34.9419	34.7407	34.5327	
alpha	3.2732	3.2806	3.2879	3.3228	3.3295	3.3609	3.3609	3.3669	3.3487	3.3295	3.3160	3.3022	
util living area													
	0.9752	0.9537	0.9126	0.8180	0.6748	0.5059	0.3785	0.4289	0.6554	0.8761	0.9578	0.9790	(86)
MIT	18.9964	19.3329	19.7984	20.3588	20.7387	20.9273	20.9791	20.9684	20.8259	20.2917	19.5531	18.9516	(87)
Th 2	19.8967	19.8999	19.9030	19.9176	19.9204	19.9332	19.9332	19.9356	19.9282	19.9204	19.9148	19.9090	(88)
util rest of house													
	0.9701	0.9446	0.8955	0.7847	0.6207	0.4321	0.2909	0.3364	0.5808	0.8447	0.9479	0.9746	(89)
MIT 2	17.5842	18.0089	18.5883	19.2685	19.6912	19.8848	19.9241	19.9206	19.7978	19.2118	18.3016	17.5352	(90)
Living area fraction										fLA = Living area / (4) =		0.1768	(91)
MIT	17.8339	18.2430	18.8023	19.4613	19.8764	20.0691	20.1106	20.1059	19.9796	19.4028	18.5229	17.7857	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8339	18.2430	18.8023	19.4613	19.8764	20.0691	20.1106	20.1059	19.9796	19.4028	18.5229	17.7857	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9565	0.9263	0.8743	0.7687	0.6183	0.4419	0.3058	0.3517	0.5847	0.8265	0.9306	0.9624	(94)
Useful gains	796.0912	938.0217	1033.3580	1067.4531	947.5514	678.3269	448.0313	468.3927	690.6064	812.5194	782.0835	757.4880	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	1818.5319	1787.0643	1642.4161	1388.7914	1072.1135	707.5635	454.1871	478.2499	764.6306	1154.2422	1506.4737	1802.4994	(97)
Space heating kWh													
	760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98a)
Space heating requirement - total per year (kWh/year)												3661.7208	
Solar heating kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh													
	760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3661.7208	
Space heating per m2											(98c) / (4) =	33.4985	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	92.3000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98)
Space heating efficiency (main heating system 1)													
	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)													
	824.1559	618.1546	490.9417	250.6648	100.4054	0.0000	0.0000	0.0000	0.0000	275.4516	565.0715	842.3494	(211)
Space heating efficiency (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

Water heating requirement													
	248.8449	220.0042	233.8487	206.2226	200.2500	180.8422	178.9101	185.8838	187.7482	208.8431	221.3853	246.2381	(64)
Efficiency of water heater												79.8000	(216)
(217)m	86.3981	86.0977	85.5169	84.3184	82.4436	79.8000	79.8000	79.8000	79.8000	84.5020	85.9127	86.4547	(217)
Fuel for water heating, kWh/month													
	288.0211	255.5284	273.4531	244.5761	242.8934	226.6193	224.1981	232.9371	235.2735	247.1457	257.6863	284.8175	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	28.3493	22.7429	20.4774	15.0026	11.5885	9.4679	10.5714	13.7411	17.8483	23.4180	26.4505	29.1372	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-48.6578	-67.9400	-96.7221	-107.6523	-115.1262	-107.0597	-105.6615	-100.1636	-90.3952	-77.0882	-53.2285	-42.1389	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-29.5450	-61.9021	-122.6002	-183.5406	-242.1517	-243.1675	-240.3759	-203.8344	-149.7674	-88.4121	-39.4035	-23.3888	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	3967.1948	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	79.8000	
Water heating fuel used	3013.1496	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	228.7951	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-2639.9231	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	4655.2164	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	3967.1948	0.2100	833.1109	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3013.1496	0.2100	632.7614	(264)
Space and water heating			1465.8723	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	228.7951	0.1443	33.0222	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1011.8340	0.1348	-136.4033	
PV Unit electricity exported	-1628.0891	0.1260	-205.1155	
Total			-341.5188	(269)
Total CO2, kg/year			1169.3049	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.7000	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	3967.1948	1.1300	4482.9301	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3013.1496	1.1300	3404.8590	(278)
Space and water heating			7887.7891	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	228.7951	1.5338	350.9336	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1011.8340	1.4982	-1515.9701	
PV Unit electricity exported	-1628.0891	0.4625	-752.9209	
Total			-2268.8910	(283)
Total Primary energy kWh/year			6099.9325	(286)
Target Primary Energy Rate (TPER)			55.8000	(287)

ii. Be Lean

Full SAP Calculation Printout

Property Reference	224 St Leonards	**Issued on Date**	15/05/2024
Assessment Reference	Option 2 - House 1	**Prop Type Ref**	224 St Leonards
Property	Land Rear of 224, St Leonards Road, LONDON, SW14 7BN		

SAP Rating	77 C	**DER**	5.06	**TER**	10.70
Environmental	95 A	**% DER < TER**			52.71
CO_2 Emissions (t/year)	0.51	**DFEE**	36.16	**TFEE**	40.70
Compliance Check	See BREL	**% DFEE < TFEE**			11.17
% DPER < TPER	3.96	**DPER**	53.59	**TPER**	55.80

Assessor Details	Mr. Mark Simons	**Assessor ID**	5542-0001
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	53.4100 (1b)	x	2.5000 (2b)	=	133.5250	(1b) - (3b)
First floor	55.9000 (1c)	x	2.0000 (2c)	=	111.8000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	109.3100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	245.3250	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1223	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.2723	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2723	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3472	0.3404	0.3336	0.2995	0.2927	0.2587	0.2587	0.2519	0.2723	0.2927	0.3063	0.3199	(22b)
Effective ac	0.5603	0.5579	0.5556	0.5449	0.5428	0.5335	0.5335	0.5317	0.5371	0.5428	0.5469	0.5512	(25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
WINDOWS (Uw = 1.20)			16.6900	1.1450	19.1107			(27)
ROOFLIGHTS			5.5200	1.1450	6.3206			(27a)
ROOFLIGHTS			1.2800	1.1450	1.4656			(27a)
UNDERGROUND			53.4100	0.1200	6.4092	75.0000	4005.7500	(28a)
EXTERNAL	108.3200	16.6900	91.6300	0.1500	13.7445	70.0000	6414.1000	(29a)
ROOF VOID	8.9800		8.9800	0.1400	1.2572	18.0000	161.6400	(29a)
PITCHED @CEILING	8.0100		8.0100	0.1100	0.8811	9.0000	72.0900	(30)
PITCHED @RAFTER	75.3900	6.8000	68.5900	0.1100	7.5449	9.0000	617.3100	(30)
Total net area of external elements Aum(A, m2)			254.1100					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	56.7338			(33)
PARTY WALL			21.3900	0.0000	0.0000	180.0000	3850.2000	(32)
FF			50.8500			18.0000	915.3000	(32d)
GF			50.8500			9.0000	457.6500	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16494.0400 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		150.8923 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E2 Other lintels (including other steel lintels)	10.8900	0.3000	3.2670

E3 Sill	8.8300	0.0400	0.3532	
E4 Jamb	27.2800	0.0500	1.3640	
E5 Ground floor (normal)	33.4000	0.1600	5.3440	
E20 Exposed floor (normal)	0.9000	0.3200	0.2880	
E6 Intermediate floor within a dwelling	11.7400	0.0700	0.8218	
E13 Gable (insulation at rafter level)	13.5000	0.0400	0.5400	
E16 Corner (normal)	15.0000	0.0900	1.3500	
E17 Corner (inverted - internal area greater than external area)	5.0000	-0.0900	-0.4500	
P7 Party Wall - Exposed floor (normal)	11.2000	0.1600	1.7920	
P5 Party wall - Roof (insulation at rafter level)	11.2000	0.0800	0.8960	
R1 Head of roof window	10.3700	0.0800	0.8296	
R2 Sill of roof window	9.0100	0.0600	0.5406	
R3 Jamb of roof window	11.6600	0.0800	0.9328	
R8 Roof to wall (rafter)	10.0400	0.0600	0.6024	
E10 Eaves (insulation at ceiling level)	11.2000	0.0600	0.6720	
E12 Gable (insulation at ceiling level)	1.6000	0.2400	0.3840	

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 19.5274 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 76.2612 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	45.3573	45.1678	44.9821	44.1099	43.9468	43.1871	43.1871	43.0464	43.4797	43.9468	44.2769	44.6220	(38)
Heat transfer coeff	121.6185	121.4291	121.2434	120.3712	120.2080	119.4484	119.4484	119.3077	119.7410	120.2080	120.5381	120.8832	(39)

Average = Sum(39)m / 12 = 120.3704

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1126	1.1109	1.1092	1.1012	1.0997	1.0927	1.0927	1.0915	1.0954	1.0997	1.1027	1.1059	(40)
HLP (average)												1.1012	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8106 (42)

Hot water usage for mixer showers

71.3447	70.2725	68.7101	65.7208	63.5148	61.0547	59.6563	61.2068	62.9065	65.5480	68.6015	71.0713	(42a)

Hot water usage for baths

32.4250	31.9435	31.2653	30.0150	29.0787	28.0406	27.4798	28.1532	28.8864	29.9973	31.2734	32.3154	(42b)

Hot water usage for other uses

45.6985	44.0367	42.3750	40.7132	39.0514	37.3897	37.3897	39.0514	40.7132	42.3750	44.0367	45.6985	(42c)

Average daily hot water use (litres/day) 137.3846 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	149.4682	146.2527	142.3504	136.4490	131.6449	126.4849	124.5258	128.4115	132.5061	137.9202	143.9116	149.0852	(44)
Energy conte	236.7210	208.2619	218.7873	186.7919	177.2194	155.5279	150.6031	159.0002	163.3933	187.1564	205.0284	233.4314	(45)
Energy content (annual)										Total = Sum(45)m =		2281.9222	
Distribution loss (46)m = 0.15 x (45)m	35.5082	31.2393	32.8181	28.0188	26.5829	23.3292	22.5905	23.8500	24.5090	28.0735	30.7543	35.0147	(46)

Water storage loss:

Store volume												200.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1000	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1340	(55)
Total storage loss	35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(56)
If cylinder contains dedicated solar storage	35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(64)
										Total per year (kWh/year) = Sum(64)m =		2969.7282	(64)
12Total per year (kWh/year)												2970	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	125.4429	111.4576	119.4799	107.3339	105.6586	96.9386	96.8087	99.6007	99.5539	108.9626	113.3975	124.3491	(65)

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	136.4389	151.0573	136.4389	140.9868	136.4389	140.9868	136.4389	136.4389	140.9868	136.4389	140.9868	136.4389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	270.5609	273.3685	266.2935	251.2317	232.2188	214.3494	202.4115	199.6039	206.6789	221.7408	240.7537	258.6231	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	(71)
Water heating gains (Table 5)	168.6060	165.8596	160.5913	149.0748	142.0142	134.6370	130.1192	133.8719	138.2693	146.4551	157.4966	167.1358	(72)
Total internal gains	640.7651	655.4447	628.4829	606.4527	575.8312	555.1325	534.1289	535.0740	551.0943	569.7941	604.3964	627.3571	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W

North	8.8900	10.6334	0.6300	0.7000	0.7700	28.8899	(74)
South	6.2600	46.7521	0.6300	0.7000	0.7700	89.4431	(78)
West	1.5400	19.6403	0.6300	0.7000	0.7700	9.2436	(80)
East	1.2800	26.6072	0.6300	0.7000	1.0000	13.5173	(82)
West	5.2200	26.6072	0.6300	0.7000	1.0000	58.2935	(82)

Solar gains	199.3873	364.9577	561.0444	789.4521	963.7180	989.9412	940.7256	806.8066	640.1402	420.5293	243.5677	167.4887	(83)
Total gains	840.1524	1020.4024	1189.5274	1395.9048	1539.5491	1545.0737	1474.8545	1341.8806	1191.2346	990.3233	847.9641	794.8458	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	37.6725	37.7313	37.7891	38.0629	38.1146	38.3570	38.3570	38.4022	38.2632	38.1146	38.0102	37.9017	
alpha	3.5115	3.5154	3.5193	3.5375	3.5410	3.5571	3.5571	3.5601	3.5509	3.5410	3.5340	3.5268	
util living area	0.9731	0.9487	0.9013	0.7959	0.6426	0.4735	0.3505	0.3988	0.6221	0.8605	0.9534	0.9774	(86)
Living	20.2992	20.3810	20.4898	20.6137	20.6924	20.7282	20.7370	20.7354	20.7088	20.5949	20.4249	20.2849	
Non living	19.1460	19.2498	19.3854	19.5383	19.6253	19.6653	19.6719	19.6723	19.6474	19.5222	19.3126	19.1331	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	31	30	31	31	30	31	30	31	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	19.9906	19.9920	19.9934	19.9999	20.0011	20.0068	20.0068	20.0078	20.0046	20.0011	19.9986	19.9960	(88)
util rest of house	0.9678	0.9391	0.8835	0.7622	0.5911	0.4069	0.2739	0.3169	0.5518	0.8281	0.9430	0.9730	(89)
MIT 2	19.9906	19.9920	19.9934	19.9999	20.0011	20.0068	20.0068	20.0078	20.0046	20.0011	19.9986	19.9960	(90)
Living area fraction										fLA = Living area / (4) =		0.1768	(91)
MIT	20.1691	20.1702	20.1714	20.1767	20.1777	20.1824	20.1824	20.1833	20.1806	20.1777	20.1757	20.1736	(92)
Temperature adjustment												0.0000	
adjusted MIT	20.1691	20.1702	20.1714	20.1767	20.1777	20.1824	20.1824	20.1833	20.1806	20.1777	20.1757	20.1736	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9688	0.9409	0.8869	0.7686	0.6006	0.4189	0.2876	0.3317	0.5649	0.8344	0.9450	0.9738	(94)
Useful gains	813.9618	960.1312	1055.0061	1072.8693	924.6524	647.3080	424.1752	445.1369	672.9454	826.3467	801.3448	774.0349	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1929.9717	1854.2491	1657.5623	1357.3924	1019.0905	666.8086	427.9119	451.3728	728.0968	1151.3193	1576.1198	1930.9377	(97)
Space heating kWh	830.3114	600.8472	448.3018	204.8567	70.2619	0.0000	0.0000	0.0000	0.0000	241.7796	557.8380	860.7356	(98a)
Space heating requirement - total per year (kWh/year)												3814.9323	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	830.3114	600.8472	448.3018	204.8567	70.2619	0.0000	0.0000	0.0000	0.0000	241.7796	557.8380	860.7356	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3814.9323	
Space heating per m2											(98c) / (4) =	34.9001	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	367.4870	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	830.3114	600.8472	448.3018	204.8567	70.2619	0.0000	0.0000	0.0000	0.0000	241.7796	557.8380	860.7356	(98)
Space heating efficiency (main heating system 1)	367.4870	367.4870	367.4870	367.4870	367.4870	0.0000	0.0000	0.0000	0.0000	367.4870	367.4870	367.4870	(210)
Space heating fuel (main heating system)	225.9431	163.5017	121.9912	55.7453	19.1196	0.0000	0.0000	0.0000	0.0000	65.7927	151.7981	234.2221	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(64)
Efficiency of water heater												116.0400	(216)
(217)m	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	116.0400	(217)
Fuel for water heating, kWh/month	254.3411	224.9440	238.8863	209.6896	203.0643	182.7473	180.1271	187.3635	189.5254	211.6277	225.4054	251.5062	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	26.3792	21.1624	19.0544	13.9600	10.7831	8.8099	9.8367	12.7862	16.6080	21.7905	24.6124	27.1123	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)

(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	1038.1137	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	116.0400	
Water heating fuel used	2559.2281	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	0.0000	(231)
Electricity for lighting (calculated in Appendix L)	212.8952	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	0.0000	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	3810.2369	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1038.1137	0.1562	162.1965	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2559.2281	0.1409	360.6321	(264)
Space and water heating			522.8286	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	212.8952	0.1443	30.7274	(268)
Total CO2, kg/year			553.5559	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			5.0600	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	1038.1137	1.5784	1638.5681	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2559.2281	1.5211	3892.7165	(278)
Space and water heating			5531.2846	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	212.8952	1.5338	326.5457	(282)
Total Primary energy kWh/year			5857.8303	(286)
Dwelling Primary energy Rate (DPER)			53.5900	(287)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	53.4100	(1b)	x 2.5000	(2b) =	133.5250	(1b) - (3b)
First floor	55.9000	(1c)	x 2.0000	(2c) =	111.8000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	109.3100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		245.3250	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
	Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.1630	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4130	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.4130	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)

Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate	0.5266	0.5163	0.5060	0.4544	0.4440	0.3924	0.3924	0.3821	0.4130	0.4440	0.4647	0.4853 (22b)
Effective ac	0.6387	0.6333	0.6280	0.6032	0.5986	0.5770	0.5770	0.5730	0.5853	0.5986	0.6080	0.6178 (25)

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3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			16.6900	1.1450	19.1107			(27)
ROOFLIGHTS			5.5200	2.0221	11.1618			(27a)
ROOFLIGHTS			1.2800	2.0221	2.5882			(27a)
UNDERGROUND			53.4100	0.1300	6.9433			(28a)
EXTERNAL	108.3200	16.6900	91.6300	0.1800	16.4934			(29a)
ROOF VOID	8.9800		8.9800	0.1800	1.6164			(29a)
PITCHED @CEILING	8.0100		8.0100	0.1100	0.8811			(30)
PITCHED @RAFTER	75.3900	6.8000	68.5900	0.1100	7.5449			(30)
Total net area of external elements Aum(A, m2)			254.1100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		66.3398			(33)
PARTY WALL			21.3900	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 150.8923 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E2	Other lintels (including other steel lintels)	10.8900	0.0500	0.5445
E3	Sill	8.8300	0.0500	0.4415
E4	Jamb	27.2800	0.0500	1.3640
E5	Ground floor (normal)	33.4000	0.1600	5.3440
E20	Exposed floor (normal)	0.9000	0.3200	0.2880
E6	Intermediate floor within a dwelling	11.7400	0.0000	0.0000
E13	Gable (insulation at rafter level)	13.5000	0.0800	1.0800
E16	Corner (normal)	15.0000	0.0900	1.3500
E17	Corner (inverted - internal area greater than external area)	5.0000	-0.0900	-0.4500
P7	Party Wall - Exposed floor (normal)	11.2000	0.1600	1.7920
P5	Party wall - Roof (insulation at rafter level)	11.2000	0.0800	0.8960
R1	Head of roof window	10.3700	0.0800	0.8296
R2	Sill of roof window	9.0100	0.0600	0.5406
R3	Jamb of roof window	11.6600	0.0800	0.9328
R8	Roof to wall (rafter)	10.0400	0.0600	0.6024
E10	Eaves (insulation at ceiling level)	11.2000	0.0600	0.6720
E12	Gable (insulation at ceiling level)	1.6000	0.0600	0.0960

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 16.3234 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 82.6632 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	51.7053	51.2693	50.8420	48.8349	48.4594	46.7113	46.7113	46.3876	47.3847	48.4594	49.2191	50.0133	(38)
Heat transfer coeff	134.3684	133.9325	133.5052	131.4981	131.1226	129.3745	129.3745	129.0508	130.0478	131.1226	131.8823	132.6765	(39)

Average = Sum(39)m / 12 = 131.4963

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2292	1.2253	1.2213	1.2030	1.1995	1.1836	1.1836	1.1806	1.1897	1.1995	1.2065	1.2138	(40)
HLP (average)												1.2030	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8106 (42)

Hot water usage for mixer showers	71.3447	70.2725	68.7101	65.7208	63.5148	61.0547	59.6563	61.2068	62.9065	65.5480	68.6015	71.0713 (42a)
Hot water usage for baths	30.8038	30.3463	29.7021	28.5142	27.6248	26.6385	26.1058	26.7455	27.4421	28.4974	29.7097	30.6996 (42b)
Hot water usage for other uses	43.4136	41.8349	40.2562	38.6775	37.0989	35.5202	35.5202	37.0989	38.6775	40.2562	41.8349	43.4136 (42c)

Average daily hot water use (litres/day) 133.8042 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	145.5620	142.4537	138.6684	132.9126	128.2384	123.2134	121.2823	125.0512	129.0261	134.3016	140.1461	145.1845	(44)
Energy conte	230.5346	202.8521	213.1282	181.9507	172.6336	151.5052	146.6804	154.8396	159.1021	182.2460	199.6638	227.3238	(45)
Energy content (annual)										Total = Sum(45)m =		2222.4601	
Distribution loss (46)m = 0.15 x (45)m	34.5802	30.4278	31.9692	27.2926	25.8950	22.7258	22.0021	23.2259	23.8653	27.3369	29.9496	34.0986	(46)

Water storage loss:

Store volume 200.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.6525 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 0.8924 (55)

Total storage loss	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(56)
If cylinder contains dedicated solar storage	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	281.4607	248.8499	264.0542	231.2340	223.5597	200.7885	197.6065	205.7656	208.3854	233.1720	248.9471	278.2499	(62)
WWHRS	-32.6158	-28.8457	-30.2055	-25.0114	-23.3097	-19.9463	-18.6965	-19.8818	-20.6372	-24.3290	-27.5618	-32.0118	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	248.8449	220.0042	233.8487	206.2226	200.2500	180.8422	178.9101	185.8838	187.7482	208.8431	221.3853	246.2381	(64)
										Total per year (kWh/year) = Sum(64)m =		2519.0212	(64)
12Total per year (kWh/year)												2519	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	117.3936	104.2465	111.6060	99.9252	98.1415	89.8021	89.5121	92.2250	92.3281	101.3376	105.8148	116.3260	(65)

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	136.4389	151.0573	136.4389	140.9868	136.4389	140.9868	136.4389	136.4389	140.9868	136.4389	140.9868	136.4389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	270.5609	273.3685	266.2935	251.2317	232.2188	214.3494	202.4115	199.6039	206.6789	221.7408	240.7537	258.6231	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	(71)
Water heating gains (Table 5)													
	157.7871	155.1288	150.0080	138.7851	131.9107	124.7252	120.3120	123.9584	128.2335	136.2065	146.9651	156.3522	(72)
Total internal gains													
	632.9462	647.7139	620.8997	599.1629	568.7276	545.2207	524.3217	525.1605	541.0586	562.5455	596.8648	619.5734	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	8.8900	10.6334	0.6300	0.7000	0.7700	28.8899	(74)
South	6.2600	46.7521	0.6300	0.7000	0.7700	89.4431	(78)
West	1.5400	19.6403	0.6300	0.7000	0.7700	9.2436	(80)
East	1.2800	26.6072	0.6300	0.7000	1.0000	13.5173	(82)
West	5.5200	26.6072	0.6300	0.7000	1.0000	58.2935	(82)

Solar gains	199.3873	364.9577	561.0444	789.4521	963.7180	989.9412	940.7256	806.8066	640.1402	420.5293	243.5677	167.4887	(83)
Total gains	832.3336	1012.6716	1181.9442	1388.6150	1532.4456	1535.1619	1465.0473	1331.9670	1181.1988	983.0747	840.4325	787.0622	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	34.0979	34.2089	34.3184	34.8422	34.9419	35.4141	35.4141	35.5029	35.2307	34.9419	34.7407	34.5327	
alpha	3.2732	3.2806	3.2879	3.3228	3.3295	3.3609	3.3609	3.3669	3.3487	3.3295	3.3160	3.3022	
util living area													
	0.9752	0.9537	0.9126	0.8180	0.6748	0.5059	0.3785	0.4289	0.6554	0.8761	0.9578	0.9790	(86)
MIT	18.9964	19.3329	19.7984	20.3588	20.7387	20.9273	20.9791	20.9684	20.8259	20.2917	19.5531	18.9516	(87)
Th 2	19.8967	19.8999	19.9030	19.9176	19.9204	19.9332	19.9332	19.9356	19.9282	19.9204	19.9148	19.9090	(88)
util rest of house													
	0.9701	0.9446	0.8955	0.7847	0.6207	0.4321	0.2909	0.3364	0.5808	0.8447	0.9479	0.9746	(89)
MIT 2	17.5842	18.0089	18.5883	19.2685	19.6912	19.8848	19.9241	19.9206	19.7978	19.2118	18.3016	17.5352	(90)
Living area fraction										fLA = Living area / (4) =		0.1768	(91)
MIT	17.8339	18.2430	18.8023	19.4613	19.8764	20.0691	20.1106	20.1059	19.9796	19.4028	18.5229	17.7857	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8339	18.2430	18.8023	19.4613	19.8764	20.0691	20.1106	20.1059	19.9796	19.4028	18.5229	17.7857	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9565	0.9263	0.8743	0.7687	0.6183	0.4419	0.3058	0.3517	0.5847	0.8265	0.9306	0.9624	(94)
Useful gains	796.0912	938.0217	1033.3580	1067.4531	947.5514	678.3269	448.0313	468.3927	690.6064	812.5194	782.0835	757.4880	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	1818.5319	1787.0643	1642.4161	1388.7914	1072.1135	707.5635	454.1871	478.2499	764.6306	1154.2422	1506.4737	1802.4994	(97)
Space heating kWh													
	760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98a)
Space heating requirement - total per year (kWh/year)												3661.7208	
Solar heating kWh													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh													
	760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3661.7208	
Space heating per m2											(98c) / (4) =	33.4985	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	92.3000	(206)
Efficiency of main space heating system 2 (in %)	0.0000	(207)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98)
Space heating efficiency (main heating system 1)													
	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)													
	824.1559	618.1546	490.9417	250.6648	100.4054	0.0000	0.0000	0.0000	0.0000	275.4516	565.0715	842.3494	(211)
Space heating efficiency (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

Water heating requirement													
	248.8449	220.0042	233.8487	206.2226	200.2500	180.8422	178.9101	185.8838	187.7482	208.8431	221.3853	246.2381	(64)
Efficiency of water heater												79.8000	(216)
(217)m	86.3981	86.0977	85.5169	84.3184	82.4436	79.8000	79.8000	79.8000	79.8000	84.5020	85.9127	86.4547	(217)
Fuel for water heating, kWh/month													
	288.0211	255.5284	273.4531	244.5761	242.8934	226.6193	224.1981	232.9371	235.2735	247.1457	257.6863	284.8175	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	28.3493	22.7429	20.4774	15.0026	11.5885	9.4679	10.5714	13.7411	17.8483	23.4180	26.4505	29.1372	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-48.6578	-67.9400	-96.7221	-107.6523	-115.1262	-107.0597	-105.6615	-100.1636	-90.3952	-77.0882	-53.2285	-42.1389	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-29.5450	-61.9021	-122.6002	-183.5406	-242.1517	-243.1675	-240.3759	-203.8344	-149.7674	-88.4121	-39.4035	-23.3888	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	3967.1948	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	79.8000	
Water heating fuel used	3013.1496	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	228.7951	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-2639.9231	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	4655.2164	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	3967.1948	0.2100	833.1109	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3013.1496	0.2100	632.7614	(264)
Space and water heating			1465.8723	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	228.7951	0.1443	33.0222	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1011.8340	0.1348	-136.4033	
PV Unit electricity exported	-1628.0891	0.1260	-205.1155	
Total			-341.5188	(269)
Total CO2, kg/year			1169.3049	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.7000	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	3967.1948	1.1300	4482.9301	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3013.1496	1.1300	3404.8590	(278)
Space and water heating			7887.7891	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	228.7951	1.5338	350.9336	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1011.8340	1.4982	-1515.9701	
PV Unit electricity exported	-1628.0891	0.4625	-752.9209	
Total			-2268.8910	(283)
Total Primary energy kWh/year			6099.9325	(286)
Target Primary Energy Rate (TPER)			55.8000	(287)

iii. Be Green

Full SAP Calculation Printout

Property Reference	224 St Leonards	**Issued on Date**	15/05/2024
Assessment Reference	Option 3 - House 1	**Prop Type Ref**	224 St Leonards
Property	Land Rear of 224, St Leonards Road, LONDON, SW14 7BN		

SAP Rating	92 A	**DER**	1.31	**TER**	10.70
Environmental	99 A	**% DER < TER**			87.76
CO_2 Emissions (t/year)	0.09	**DFEE**	36.16	**TFEE**	40.70
Compliance Check	See BREL	**% DFEE < TFEE**			11.17
% DPER < TPER	64.57	**DPER**	19.77	**TPER**	55.80

Assessor Details	Mr. Mark Simons	**Assessor ID**	5542-0001
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	53.4100 (1b)	x	2.5000 (2b)	=	133.5250	(1b) - (3b)
First floor	55.9000 (1c)	x	2.0000 (2c)	=	111.8000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	109.3100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	245.3250	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	3 * 10 =	30.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.1223	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		3.0000	(17)
Infiltration rate		0.2723	(18)
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2723	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3472	0.3404	0.3336	0.2995	0.2927	0.2587	0.2587	0.2519	0.2723	0.2927	0.3063	0.3199	(22b)
Effective ac	0.5603	0.5579	0.5556	0.5449	0.5428	0.5335	0.5335	0.5317	0.5371	0.5428	0.5469	0.5512	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
WINDOWS (Uw = 1.20)			16.6900	1.1450	19.1107			(27)
ROOFLIGHTS			5.5200	1.1450	6.3206			(27a)
ROOFLIGHTS			1.2800	1.1450	1.4656			(27a)
UNDERGROUND			53.4100	0.1200	6.4092	75.0000	4005.7500	(28a)
EXTERNAL	108.3200	16.6900	91.6300	0.1500	13.7445	70.0000	6414.1000	(29a)
ROOF VOID	8.9800		8.9800	0.1400	1.2572	18.0000	161.6400	(29a)
PITCHED @CEILING	8.0100		8.0100	0.1100	0.8811	9.0000	72.0900	(30)
PITCHED @RAFTER	75.3900	6.8000	68.5900	0.1100	7.5449	9.0000	617.3100	(30)
Total net area of external elements Aum(A, m2)			254.1100					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	56.7338			(33)
PARTY WALL			21.3900	0.0000	0.0000	180.0000	3850.2000	(32)
FF			50.8500			18.0000	915.3000	(32d)
GF			50.8500			9.0000	457.6500	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	16494.0400 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		150.8923 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element			
E2 Other lintels (including other steel lintels)	10.8900	0.3000	3.2670

E3 Sill	8.8300	0.0400	0.3532	
E4 Jamb	27.2800	0.0500	1.3640	
E5 Ground floor (normal)	33.4000	0.1600	5.3440	
E20 Exposed floor (normal)	0.9000	0.3200	0.2880	
E6 Intermediate floor within a dwelling	11.7400	0.0700	0.8218	
E13 Gable (insulation at rafter level)	13.5000	0.0400	0.5400	
E16 Corner (normal)	15.0000	0.0900	1.3500	
E17 Corner (inverted - internal area greater than external area)	5.0000	-0.0900	-0.4500	
P7 Party Wall - Exposed floor (normal)	11.2000	0.1600	1.7920	
P5 Party wall - Roof (insulation at rafter level)	11.2000	0.0800	0.8960	
R1 Head of roof window	10.3700	0.0800	0.8296	
R2 Sill of roof window	9.0100	0.0600	0.5406	
R3 Jamb of roof window	11.6600	0.0800	0.9328	
R8 Roof to wall (rafter)	10.0400	0.0600	0.6024	
E10 Eaves (insulation at ceiling level)	11.2000	0.0600	0.6720	
E12 Gable (insulation at ceiling level)	1.6000	0.2400	0.3840	

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 19.5274 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 76.2612 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	45.3573	45.1678	44.9821	44.1099	43.9468	43.1871	43.1871	43.0464	43.4797	43.9468	44.2769	44.6220	(38)
Heat transfer coeff	121.6185	121.4291	121.2434	120.3712	120.2080	119.4484	119.4484	119.3077	119.7410	120.2080	120.5381	120.8832	(39)

Average = Sum(39)m / 12 = 120.3704

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1126	1.1109	1.1092	1.1012	1.0997	1.0927	1.0927	1.0915	1.0954	1.0997	1.1027	1.1059	(40)
HLP (average)												1.1012	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8106 (42)

Hot water usage for mixer showers

71.3447	70.2725	68.7101	65.7208	63.5148	61.0547	59.6563	61.2068	62.9065	65.5480	68.6015	71.0713	(42a)

Hot water usage for baths

32.4250	31.9435	31.2653	30.0150	29.0787	28.0406	27.4798	28.1532	28.8864	29.9973	31.2734	32.3154	(42b)

Hot water usage for other uses

45.6985	44.0367	42.3750	40.7132	39.0514	37.3897	37.3897	39.0514	40.7132	42.3750	44.0367	45.6985	(42c)

Average daily hot water use (litres/day) 137.3846 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	149.4682	146.2527	142.3504	136.4490	131.6449	126.4849	124.5258	128.4115	132.5061	137.9202	143.9116	149.0852	(44)
Energy conte	236.7210	208.2619	218.7873	186.7919	177.2194	155.5279	150.6031	159.0002	163.3933	187.1564	205.0284	233.4314	(45)

Energy content (annual) Total = Sum(45)m = 2281.9222

Distribution loss (46)m = 0.15 x (45)m

35.5082	31.2393	32.8181	28.0188	26.5829	23.3292	22.5905	23.8500	24.5090	28.0735	30.7543	35.0147	(46)

Water storage loss:

Store volume 200.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 2.1000 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 1.1340 (55)

Total storage loss

35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(56)

If cylinder contains dedicated solar storage

35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)

Total heat required for water heating calculated for each month

295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)

Output from w/h

295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(64)

Total per year (kWh/year) = Sum(64)m = 2969.7282 (64)

12Total per year (kWh/year) 2970 (64)

Electric shower(s)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a)

Heat gains from water heating, kWh/month

125.4429	111.4576	119.4799	107.3339	105.6586	96.9386	96.8087	99.6007	99.5539	108.9626	113.3975	124.3491	(65)

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	136.4389	151.0573	136.4389	140.9868	136.4389	140.9868	136.4389	136.4389	140.9868	136.4389	140.9868	136.4389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	270.5609	273.3685	266.2935	251.2317	232.2188	214.3494	202.4115	199.6039	206.6789	221.7408	240.7537	258.6231	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	(71)
Water heating gains (Table 5)	168.6060	165.8596	160.5913	149.0748	142.0142	134.6370	130.1192	133.8719	138.2693	146.4551	157.4966	167.1358	(72)
Total internal gains	640.7651	655.4447	628.4829	606.4527	575.8312	555.1325	534.1289	535.0740	551.0943	569.7941	604.3964	627.3571	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W

North	8.8900	10.6334	0.6300	0.7000	0.7700	28.8899 (74)
South	6.2600	46.7521	0.6300	0.7000	0.7700	89.4431 (78)
West	1.5400	19.6403	0.6300	0.7000	0.7700	9.2436 (80)
East	1.2800	26.6072	0.6300	0.7000	1.0000	13.5173 (82)
West	5.2200	26.6072	0.6300	0.7000	1.0000	58.2935 (82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	199.3873	364.9577	561.0444	789.4521	963.7180	989.9412	940.7256	806.8066	640.1402	420.5293	243.5677	167.4887	(83)
Total gains	840.1524	1020.4024	1189.5274	1395.9048	1539.5491	1545.0737	1474.8545	1341.8806	1191.2346	990.3233	847.9641	794.8458	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	37.6725	37.7313	37.7891	38.0629	38.1146	38.3570	38.3570	38.4022	38.2632	38.1146	38.0102	37.9017	
alpha	3.5115	3.5154	3.5193	3.5375	3.5410	3.5571	3.5571	3.5601	3.5509	3.5410	3.5340	3.5268	
util living area	0.9731	0.9487	0.9013	0.7959	0.6426	0.4735	0.3505	0.3988	0.6221	0.8605	0.9534	0.9774	(86)
Living	20.2992	20.3810	20.4898	20.6137	20.6924	20.7282	20.7370	20.7354	20.7088	20.5949	20.4249	20.2849	
Non living	19.1460	19.2498	19.3854	19.5383	19.6253	19.6653	19.6719	19.6723	19.6474	19.5222	19.3126	19.1331	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.6415	20.3810	20.4898	20.6137	20.6924	20.7282	20.7370	20.7354	20.7088	20.5949	20.4249	20.3849	(87)
Th 2	19.9906	19.9920	19.9934	19.9999	20.0011	20.0068	20.0068	20.0078	20.0046	20.0011	19.9986	19.9960	(88)
util rest of house	0.9678	0.9391	0.8835	0.7622	0.5911	0.4069	0.2739	0.3169	0.5518	0.8281	0.9430	0.9730	(89)
MIT 2	19.6539	19.2498	19.3854	19.5383	19.6253	19.6653	19.6719	19.6723	19.6474	19.5222	19.3126	19.2886	(90)
Living area fraction										fLA = Living area / (4) =		0.1768	(91)
MIT	19.8285	19.4499	19.5807	19.7285	19.8140	19.8533	19.8603	19.8603	19.8351	19.7119	19.5093	19.4824	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.8285	19.4499	19.5807	19.7285	19.8140	19.8533	19.8603	19.8603	19.8351	19.7119	19.5093	19.4824	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9668	0.9331	0.8751	0.7522	0.5808	0.3962	0.2623	0.3044	0.5389	0.8173	0.9369	0.9702	(94)
Useful gains	812.2978	952.0952	1040.9879	1049.9482	894.1437	612.1314	386.9133	408.5149	641.9404	809.3798	794.4697	771.1952	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1888.5559	1766.7752	1585.9481	1303.4366	975.3717	627.4942	389.4318	412.8355	686.7307	1095.3236	1495.7975	1847.3908	(97)
Space heating kWh	800.7360	547.4649	405.4504	182.5116	60.4336	0.0000	0.0000	0.0000	0.0000	212.7422	504.9560	800.6895	(98a)
Space heating requirement - total per year (kWh/year)												3514.9842	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	800.7360	547.4649	405.4504	182.5116	60.4336	0.0000	0.0000	0.0000	0.0000	212.7422	504.9560	800.6895	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												3514.9842	
Space heating per m2											(98c) / (4) =	32.1561	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)
Fraction of space heat from main system(s) 1.0000 (202)
Efficiency of main space heating system 1 (in %) 363.1276 (206)
Efficiency of main space heating system 2 (in %) 0.0000 (207)
Efficiency of secondary/supplementary heating system, % 0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	800.7360	547.4649	405.4504	182.5116	60.4336	0.0000	0.0000	0.0000	0.0000	212.7422	504.9560	800.6895	(98)
Space heating efficiency (main heating system 1)	363.1276	363.1276	363.1276	363.1276	363.1276	0.0000	0.0000	0.0000	0.0000	363.1276	363.1276	363.1276	(210)
Space heating fuel (main heating system)	220.5109	150.7638	111.6551	50.2610	16.6425	0.0000	0.0000	0.0000	0.0000	58.5861	139.0574	220.4981	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	295.1374	261.0251	277.2037	243.3239	235.6358	212.0599	209.0195	217.4166	219.9253	245.5728	261.5604	291.8478	(64)
Efficiency of water heater												219.0470	(216)
(217)m	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	219.0470	(217)
Fuel for water heating, kWh/month	134.7370	119.1640	126.5499	111.0829	107.5732	96.8102	95.4222	99.2557	100.4010	112.1096	119.4084	133.2352	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	26.3792	21.1624	19.0544	13.9600	10.7831	8.8099	9.8367	12.7862	16.6080	21.7905	24.6124	27.1123	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-31.2497	-50.7507	-84.0920	-104.1727	-117.6413	-110.4289	-108.3220	-98.3145	-80.5530	-60.7648	-35.9571	-26.0121	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	-8.3419	-21.5459	-54.2120	-100.9419	-151.2610	-159.8920	-155.9432	-122.5511	-78.3310	-35.9140	-12.2659	-6.2497	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)												
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year		
Space heating fuel - main system 1	967.9749	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	219.0470	
Water heating fuel used	1355.7493	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	0.0000	(231)
Electricity for lighting (calculated in Appendix L)	212.8952	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-1815.7085	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	720.9109	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	967.9749	0.1564	151.4394	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1355.7493	0.1409	191.0446	(264)
Space and water heating			342.4840	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	212.8952	0.1443	30.7274	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-908.2589	0.1327	-120.5527	
PV Unit electricity exported	-907.4496	0.1209	-109.7419	
Total			-230.2945	(269)
Total CO2, kg/year			142.9168	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			1.3100	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	967.9749	1.5792	1528.5910	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1355.7493	1.5211	2062.1639	(278)
Space and water heating			3590.7550	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	212.8952	1.5338	326.5457	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-908.2589	1.4905	-1353.7177	
PV Unit electricity exported	-907.4496	0.4437	-402.5988	
Total			-1756.3165	(283)
Total Primary energy kWh/year			2160.9842	(286)
Dwelling Primary energy Rate (DPER)			19.7700	(287)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS

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1. Overall dwelling characteristics

		Area (m2)		Storey height (m)		Volume (m3)	
Ground floor		53.4100 (1b)	x	2.5000 (2b)	=	133.5250	(1b) - (3b)
First floor		55.9000 (1c)	x	2.0000 (2c)	=	111.8000	(1c) - (3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	109.3100						(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	245.3250	(5)

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2. Ventilation rate

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		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	4 * 10 =	40.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)
		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.1630	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	

Measured/design AP50	5.0000	(17)
Infiltration rate	0.4130	(18)
Number of sides sheltered	0	(19)
Shelter factor (20) = 1 - [0.075 x (19)] =	1.0000	(20)
Infiltration rate adjusted to include shelter factor (21) = (18) x (20) =	0.4130	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.5266	0.5163	0.5060	0.4544	0.4440	0.3924	0.3924	0.3821	0.4130	0.4440	0.4647	0.4853	(22b)
Effective ac	0.6387	0.6333	0.6280	0.6032	0.5986	0.5770	0.5770	0.5730	0.5853	0.5986	0.6080	0.6178	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opening Type (Uw = 1.20)			16.6900	1.1450	19.1107			(27)
ROOFLIGHTS			5.5200	2.0221	11.1618			(27a)
ROOFLIGHTS			1.2800	2.0221	2.5882			(27a)
UNDERGROUND			53.4100	0.1300	6.9433			(28a)
EXTERNAL	108.3200	16.6900	91.6300	0.1800	16.4934			(29a)
ROOF VOID	8.9800		8.9800	0.1800	1.6164			(29a)
PITCHED @CEILING	8.0100		8.0100	0.1100	0.8811			(30)
PITCHED @RAFTER	75.3900	6.8000	68.5900	0.1100	7.5449			(30)
Total net area of external elements Aum(A, m2)			254.1100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		66.3398			(33)
PARTY WALL			21.3900	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 150.8923 (35)

List of Thermal Bridges

	K1 Element	Length	Psi-value	Total
E2	Other lintels (including other steel lintels)	10.8900	0.0500	0.5445
E3	Sill	8.8300	0.0500	0.4415
E4	Jamb	27.2800	0.0500	1.3640
E5	Ground floor (normal)	33.4000	0.1600	5.3440
E20	Exposed floor (normal)	0.9000	0.3200	0.2880
E6	Intermediate floor within a dwelling	11.7400	0.0000	0.0000
E13	Gable (insulation at rafter level)	13.5000	0.0800	1.0800
E16	Corner (normal)	15.0000	0.0900	1.3500
E17	Corner (inverted - internal area greater than external area)	5.0000	-0.0900	-0.4500
P7	Party Wall - Exposed floor (normal)	11.2000	0.1600	1.7920
P5	Party wall - Roof (insulation at rafter level)	11.2000	0.0800	0.8960
R1	Head of roof window	10.3700	0.0800	0.8296
R2	Sill of roof window	9.0100	0.0600	0.5406
R3	Jamb of roof window	11.6600	0.0800	0.9328
R8	Roof to wall (rafter)	10.0400	0.0600	0.6024
E10	Eaves (insulation at ceiling level)	11.2000	0.0600	0.6720
E12	Gable (insulation at ceiling level)	1.6000	0.0600	0.0960

Thermal bridges (Sum(L x Psi) calculated using Appendix K)	16.3234	(36)
Point Thermal bridges (36a) =	0.0000	
Total fabric heat loss (33) + (36) + (36a) =	82.6632	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	51.7053	51.2693	50.8420	48.8349	48.4594	46.7113	46.7113	46.3876	47.3847	48.4594	49.2191	50.0133	(38)
Heat transfer coeff	134.3684	133.9325	133.5052	131.4981	131.1226	129.3745	129.3745	129.0508	130.0478	131.1226	131.8823	132.6765	(39)
Average = Sum(39)m / 12 =												131.4963	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2292	1.2253	1.2213	1.2030	1.1995	1.1836	1.1836	1.1806	1.1897	1.1995	1.2065	1.2138	(40)
HLP (average)												1.2030	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.8106	(42)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage for mixer showers	71.3447	70.2725	68.7101	65.7208	63.5148	61.0547	59.6563	61.2068	62.9065	65.5480	68.6015	71.0713	(42a)
Hot water usage for baths	30.8038	30.3463	29.7021	28.5142	27.6248	26.6385	26.1058	26.7455	27.4421	28.4974	29.7097	30.6996	(42b)
Hot water usage for other uses	43.4136	41.8349	40.2562	38.6775	37.0989	35.5202	35.5202	37.0989	38.6775	40.2562	41.8349	43.4136	(42c)
Average daily hot water use (litres/day)												133.8042	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	145.5620	142.4537	138.6684	132.9126	128.2384	123.2134	121.2823	125.0512	129.0261	134.3016	140.1461	145.1845	(44)
Energy conte	230.5346	202.8521	213.1282	181.9507	172.6336	151.5052	146.6804	154.8396	159.1021	182.2460	199.6638	227.3238	(45)
Energy content (annual)										Total = Sum(45)m =		2222.4601	
Distribution loss (46)m = 0.15 x (45)m	34.5802	30.4278	31.9692	27.2926	25.8950	22.7258	22.0021	23.2259	23.8653	27.3369	29.9496	34.0986	(46)
Water storage loss:													
Store volume												200.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.6525	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.8924	(55)
Total storage loss	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(56)
If cylinder contains dedicated solar storage	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	281.4607	248.8499	264.0542	231.2340	223.5597	200.7885	197.6065	205.7656	208.3854	233.1720	248.9471	278.2499	(62)
WWHRS	-32.6158	-28.8457	-30.2055	-25.0114	-23.3097	-19.9463	-18.6965	-19.8818	-20.6372	-24.3290	-27.5618	-32.0118	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	248.8449	220.0042	233.8487	206.2226	200.2500	180.8422	178.9101	185.8838	187.7482	208.8431	221.3853	246.2381	(64)

											Total per year (kWh/year) = Sum(64)m =	2519.0212	(64)
12Total per year (kWh/year)												2519	(64)
Electric shower(s)													
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
											Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =	0.0000	(64a)
Heat gains from water heating, kWh/month													
117.3936	104.2465	111.6060	99.9252	98.1415	89.8021	89.5121	92.2250	92.3281	101.3376	105.8148	116.3260	(65)	

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	140.5310	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	136.4389	151.0573	136.4389	140.9868	136.4389	140.9868	136.4389	136.4389	140.9868	136.4389	140.9868	136.4389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	270.5609	273.3685	266.2935	251.2317	232.2188	214.3494	202.4115	199.6039	206.6789	221.7408	240.7537	258.6231	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	37.0531	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	-112.4248	(71)
Water heating gains (Table 5)													
	157.7871	155.1288	150.0080	138.7851	131.9107	124.7252	120.3120	123.9584	128.2335	136.2065	146.9651	156.3522	(72)
Total internal gains													
	632.9462	647.7139	620.8997	599.1629	568.7276	545.2207	524.3217	525.1605	541.0586	562.5455	596.8648	619.5734	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	8.8900	10.6334	0.6300	0.7000	0.7700	28.8899	(74)
South	6.2600	46.7521	0.6300	0.7000	0.7700	89.4431	(78)
West	1.5400	19.6403	0.6300	0.7000	0.7700	9.2436	(80)
East	1.2800	26.6072	0.6300	0.7000	1.0000	13.5173	(82)
West	5.5200	26.6072	0.6300	0.7000	1.0000	58.2935	(82)

Solar gains	199.3873	364.9577	561.0444	789.4521	963.7180	989.9412	940.7256	806.8066	640.1402	420.5293	243.5677	167.4887	(83)
Total gains	832.3336	1012.6716	1181.9442	1388.6150	1532.4456	1535.1619	1465.0473	1331.9670	1181.1988	983.0747	840.4325	787.0622	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	34.0979	34.2089	34.3184	34.8422	34.9419	35.4141	35.4141	35.5029	35.2307	34.9419	34.7407	34.5327	
alpha	3.2732	3.2806	3.2879	3.3228	3.3295	3.3609	3.3609	3.3669	3.3487	3.3295	3.3160	3.3022	
util living area													
	0.9752	0.9537	0.9126	0.8180	0.6748	0.5059	0.3785	0.4289	0.6554	0.8761	0.9578	0.9790	(86)
MIT	18.9964	19.3329	19.7984	20.3588	20.7387	20.9273	20.9791	20.9684	20.8259	20.2917	19.5531	18.9516	(87)
Th 2	19.8967	19.8999	19.9030	19.9176	19.9204	19.9332	19.9332	19.9356	19.9282	19.9204	19.9148	19.9090	(88)
util rest of house													
	0.9701	0.9446	0.8955	0.7847	0.6207	0.4321	0.2909	0.3364	0.5808	0.8447	0.9479	0.9746	(89)
MIT 2	17.5842	18.0089	18.5883	19.2685	19.6912	19.8848	19.9241	19.9206	19.7978	19.2118	18.3016	17.5352	(90)
Living area fraction										fLA = Living area / (4) =		0.1768	(91)
MIT	17.8339	18.2430	18.8023	19.4613	19.8764	20.0691	20.1106	20.1059	19.9796	19.4028	18.5229	17.7857	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.8339	18.2430	18.8023	19.4613	19.8764	20.0691	20.1106	20.1059	19.9796	19.4028	18.5229	17.7857	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9565	0.9263	0.8743	0.7687	0.6183	0.4419	0.3058	0.3517	0.5847	0.8265	0.9306	0.9624	(94)
Useful gains	796.0912	938.0217	1033.3580	1067.4531	947.5514	678.3269	448.0313	468.3927	690.6064	812.5194	782.0835	757.4880	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
1818.5319	1787.0643	1642.4161	1388.7914	1072.1135	707.5635	454.1871	478.2499	764.6306	1154.2422	1506.4737	1802.4994	(97)	
Space heating kWh													
760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98a)	
Space heating requirement - total per year (kWh/year)												3661.7208	
Solar heating kWh													
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)	
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh													
760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98c)	
Space heating requirement after solar contribution - total per year (kWh/year)												3661.7208	
Space heating per m2											(98c) / (4) =	33.4985	(99)

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												92.3000	(206)
Efficiency of main space heating system 2 (in %)												0.0000	(207)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
760.6959	570.5567	453.1392	231.3636	92.6742	0.0000	0.0000	0.0000	0.0000	254.2418	521.5610	777.4885	(98)	
Space heating efficiency (main heating system 1)													
92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)	

Space heating fuel (main heating system)

824.1559	618.1546	490.9417	250.6648	100.4054	0.0000	0.0000	0.0000	0.0000	275.4516	565.0715	842.3494	(211)

Space heating efficiency (main heating system 2)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)

Space heating fuel (main heating system 2)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)

Space heating fuel (secondary)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

Water heating requirement

248.8449	220.0042	233.8487	206.2226	200.2500	180.8422	178.9101	185.8838	187.7482	208.8431	221.3853	246.2381	(64)

Efficiency of water heater

											79.8000	(216)
(217)m	86.3981	86.0977	85.5169	84.3184	82.4436	79.8000	79.8000	79.8000	79.8000	84.5020	85.9127	86.4547	(217)

Fuel for water heating, kWh/month

288.0211	255.5284	273.4531	244.5761	242.8934	226.6193	224.1981	232.9371	235.2735	247.1457	257.6863	284.8175	(219)

Space cooling fuel requirement

(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	28.3493	22.7429	20.4774	15.0026	11.5885	9.4679	10.5714	13.7411	17.8483	23.4180	26.4505	29.1372	(232)

Electricity generated by PVs (Appendix M) (negative quantity)

(233a)m	-48.6578	-67.9400	-96.7221	-107.6523	-115.1262	-107.0597	-105.6615	-100.1636	-90.3952	-77.0882	-53.2285	-42.1389	(233a)

Electricity generated by wind turbines (Appendix M) (negative quantity)

(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)

Electricity generated by hydro-electric generators (Appendix M) (negative quantity)

(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)

(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)

Electricity generated by PVs (Appendix M) (negative quantity)

(233b)m	-29.5450	-61.9021	-122.6002	-183.5406	-242.1517	-243.1675	-240.3759	-203.8344	-149.7674	-88.4121	-39.4035	-23.3888	(233b)

Electricity generated by wind turbines (Appendix M) (negative quantity)

(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)

Electricity generated by hydro-electric generators (Appendix M) (negative quantity)

(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)

Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)

(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year

Space heating fuel - main system 1	3967.1948	(211)
Space heating fuel - main system 2	0.0000	(213)
Space heating fuel - secondary	0.0000	(215)
Efficiency of water heater	79.8000	
Water heating fuel used	3013.1496	(219)
Space cooling fuel	0.0000	(221)
Electricity for pumps and fans:		
Total electricity for the above, kWh/year	86.0000	(231)
Electricity for lighting (calculated in Appendix L)	228.7951	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
PV generation	-2639.9231	(233)
Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	4655.2164	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	3967.1948	0.2100	833.1109	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	3013.1496	0.2100	632.7614	(264)
Space and water heating			1465.8723	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	228.7951	0.1443	33.0222	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1011.8340	0.1348	-136.4033	
PV Unit electricity exported	-1628.0891	0.1260	-205.1155	
Total			-341.5188	(269)
Total CO2, kg/year			1169.3049	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.7000	(273)

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	3967.1948	1.1300	4482.9301	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	3013.1496	1.1300	3404.8590	(278)
Space and water heating			7887.7891	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	228.7951	1.5338	350.9336	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1011.8340	1.4982	-1515.9701	
PV Unit electricity exported	-1628.0891	0.4625	-752.9209	
Total			-2268.8910	(283)
Total Primary energy kWh/year			6099.9325	(286)
Target Primary Energy Rate (TPER)			55.8000	(287)

B. GHA Overheating Tool

EARLY STAGE OVERHEATING RISK TOOL

Version 1.0, July 2019

This tool provides guidance on how to assess overheating risk in residential schemes at the early stages of design. It is specifically a pre-detail design assessment intended to help identify factors that could contribute to or mitigate the likelihood of overheating.

The questions can be answered for an overall scheme or for individual units. Score zero wherever the question does not apply. Additional information is provided in the accompanying guidance, with examples of scoring and advice on next steps.

Find out more information and download accompanying guidance at goodhomes.org.uk/overheating-in-new-homes.

Good Homes Alliance

KEY FACTORS INCREASING THE LIKELIHOOD OF OVERHEATING | **KEY FACTORS REDUCING THE LIKELIHOOD OF OVERHEATING**

Geographical and local context

#1 Where is the scheme in the UK?
See guidance for map

South east	4	4
Northern England, Scotland & NI	0	
Rest of England and Wales	2	

#2 Is the site likely to see an Urban Heat Island effect?
See guidance for details

Central London (see guidance)	3	2
Grtr London, Manchester, B'ham	2	
Other cities, towns & dense sub-urban areas	1	

#8 Do the site surroundings feature significant blue/green infrastructure?
Proximity to green spaces and large water bodies has beneficial effects on local temperatures; as guidance, this would require at least 50% of surroundings within a 100m radius to be blue/green, or a rural context

1	0

Site characteristics

#3 Does the site have barriers to windows opening?
- Noise/Acoustic risks
- Poor air quality/smells e.g. near factory or car park or very busy road
- Security risks/crime
- Adjacent to heat rejection plant

Day - reasons to keep all windows closed	8	0
Day - barriers some of the time, or for some windows e.g. on quiet side	4	
Night - reasons to keep all windows closed	8	0
Night - bedroom windows OK to open, but other windows are likely to stay closed	4	

#9 Are immediate surrounding surfaces in majority pale in colour, or blue/green?
Lighter surfaces reflect more heat and absorb less so their temperatures remain lower; consider horizontal and vertical surfaces within 10m of the scheme

1	1

#10 Does the site have existing tall trees or buildings that will shade solar-exposed glazed areas?
Shading onto east, south and west facing areas can reduce solar gains, but may also reduce daylight levels

1	1

Scheme characteristics and dwelling design

#4 Are the dwellings flats?
Flats often combine a number of factors contributing to overheating risk e.g. dwelling size, heat gains from surrounding areas; other dense and enclosed dwellings may be similarly affected - see guidance for examples

3	0

#5 Does the scheme have community heating?
i.e. with hot pipework operating during summer, especially in internal areas, leading to heat gains and higher temperatures

3	0

#11 Do dwellings have high exposed thermal mass AND a means for secure and quiet night ventilation?
Thermal mass can help slow down temperature rises, but it can also cause properties to be slower to cool, so needs to be used with care - see guidance

1	1

#12 Do floor-to-ceiling heights allow ceiling fans, now or in the future?
Higher ceilings increase stratification and air movement, and offer the potential for ceiling fans

>2.8m and fan installed	2	1
> 2.8m	1	

Solar heat gains and ventilation

#6 What is the estimated average glazing ratio for the dwellings?
(as a proportion of the facade on solar-exposed areas i.e. orientations facing east, south, west, and anything in between). Higher proportions of glazing allow higher heat gains into the space

>65%	12	4
>50%	7	
>35%	4	

#7 Are the dwellings single aspect?
Single aspect dwellings have all openings on the same facade. This reduces the potential for ventilation

Single-aspect	3	0
Dual aspect	0	

#13 Is there useful external shading?
Shading should apply to solar exposed (E/S/W) glazing. It may include shading devices, balconies above, facade articulation etc. See guidance on "full" and "part". Scoring depends on glazing proportions as per **#6**

	Full	Part	
>65%	6	3	1
>50%	4	2	
>35%	2	1	

#14 Do windows & openings support effective ventilation?
Larger, effective and secure openings will help dissipate heat - see guidance

	Openings compared to Part F purge rates		
	= Part F	+50%	+100%
Single-aspect	minimum required	3	4
Dual aspect		2	3

2

TOTAL SCORE 3 = Sum of contributing factors: 10 *minus* Sum of mitigating factors: 7

High 12 **Medium** 8 **Low**

score >12:
Incorporate design changes to reduce risk factors and increase mitigation factors
AND Carry out a detailed assessment (e.g. dynamic modelling against CIBSE TM59)

score between 8 and 12:
Seek design changes to reduce risk factors and/or increase mitigation factors
AND Carry out a detailed assessment (e.g. dynamic modelling against CIBSE TM59)

score <8:
Ensure the mitigating measures are retained, and that risk factors do not increase (e.g. in planning conditions)